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ABSTRACT

This publication of the Commission on Undergraduate Education in the Biological Sciences contains the final report of activities of the Commission during the years 1963-1972. The Commission was established to narrow the gap between current biological research and undergraduate biology teaching. In keeping with this objective, the report is divided into 19 separate topics. These are listed as History and Objectives, The Commission, Executive Office Staff, Budget, Undergraduate Major Curricula, Biology in a Liberal Education, Biology in the Two-Year College, Laboratory in Biology, Instructional Materials and Methods, Evaluation and Testing, Biological Facilities, College Instructional Personnel, Preparation of Biology Teachers, Preprofessional Training for the Medical Sciences, Preprofessional Training for the Agricultural Sciences, Interdisciplinary Cooperation, Conferences, The Consultant Bureau, and Publications. The Commission set up a number of panel groups to study different aspects of undergraduate biology teaching and their major recommendations are listed under separate titles. A list of 35 publications, in addition to two working papers published by the Commission, is included. (PS)

CUEBS News

COMMISSION ON UNDERGRADUATE EDUCATION IN THE BIOLOGICAL SCIENCES

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CUEBS, 1963 to 1972: ITS HISTORY AND FINAL REPORT

Edward J. Kormondy
Director, 1968-72

Writing the final report on a grant-supported project is an onus few enjoy and anathema to everyone else. Yet, it does provide opportunity for reflection and review of accomplishments and successes as well as of shortcomings and failures. CUEBS, in my view, had its pluses and minuses, more of the former than the latter. The depth of its concern was matched, in large measure, by the range of its purview. The intent of this final report is to reflect that depth and range by consolidating into one document the activities of the Commission on Undergraduate Education in the Biological Sciences over its 8 active (1963-71) and 1 "clean up" (1971-72) year. The effectiveness of this depth and range must perforce be judged by evaluation of the teaching of undergraduate biology in the 1970s as compared to the early 1960s: I leave that judgment to those whose noses have not been so close to the CUEBS grindstone.

The report is organized around the major foci of CUEBS activities, as follows:

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HISTORY AND OBJECTIVES

Overview

The Commission on Undergraduate Education in the Biological Sciences (CUEBS) was organized early in 1963 upon the recommendation of the Education Committee of the American Institute of Biological Sciences. It was one of eight college commissions established in the early 1960s to serve as planning and coordinating groups for the improvement of college and university education in the sciences and mathematics. All the commissions were supported by the National Science Foundation. Washington University (St. Louis) served as the first grant administrator (1963-65), George Washington University as the second (1965-69), and the American Institute of Biological Sciences as the final one (1969-72). In each instance, the relationships between CUEBS and the grant-administrating institution were excellent. The original CUEBS office was located at Washington University and was relocated in Washington, D.C. in 1964. There the office was successively located in the Lisner Library of George Washington University (1964-65), 1750 Pennsylvania Ave., N.W. (1965-66), 1717 Massachusetts Ave., N.W. (1966-69), and terminally in the AIBS headquarters at 3900 Wisconsin Ave., N.W. (1969-71).

CUEBS was charged with narrowing the gap between what is known in biology as its research frontiers and what is presented in the undergraduate classroom. It was recognized at the outset that this gap (expressed in temporal terms) may be as little as 2 or 3 years in the best institutions; in the poorest, it may be as much as 2 or 3 decades. CUEBS' activities were, for the most part, aimed at the largest group of institutions, those that fell between these two extremes. Personnel at these institutions generally welcomed the chance to communicate with others on educational problems of mutual concern, and it was largely to aid in this communication that CUEBS came into existence. From the start, CUEBS attempted to assert positive leadership in making the teaching of biology truly representative of the science of biology.

CUEBS' programs were designed to stimulate, encourage, and coordinate the efforts of colleges and universities to improve undergraduate education in the biological sciences. Emphasis was on the identification and development of improved courses and curricula, with consideration of the needs of varying student groups, including those planning graduate study in biology as well as those preparing for careers at the baccalaureate level. Attention was also given to the role of biology in a liberal education and the development of improved courses for nonmajors. Another large area of concern was the preparation and updating of biology teachers at the elementary, secondary, and college levels.

CUEBS' guiding philosophy throughout its tenure was to help institutions help themselves by helping teaching biologists to help themselves. It attempted to reflect the best thinking of the biological community and to direct this reflection to the widest possible audience.

Statement of Objectives and Procedures

In large measure, the objectives and operational procedure of CUEBS were very well outlined by Earl D. Hanson, a founding member of the Commission and its Chairman from 1965-67 in an article entitled, "Teaching and research —the gap and its cure" which appeared in **CUEBS News**, April 1966. The majority of that article follows:

A CUEBS' program without a CUEBS' problem is very like a scientist trying to do research without having first formulated a testable question. So let me start by stating what it is that CUEBS is aiming at and then speak of the activities of this Commission as it tries to meet these aims.

Perhaps the briefest formulation of our problem is to ask: How can we get teaching to reflect the contemporary state of biology as a science? This admits that there is a gap between the present research frontiers of biology and what is all too often taught in the college laboratory and classroom as representative of biology, and it clearly assumes that this gap is undesirable. Ideally, we all want to see our college students gaining an awareness of the facts and ideas that our age is generating. To have it otherwise ill-equips them in the use of knowledge, and it impedes their progress as generators of knowledge. . . .

The gap between teaching and research is the problem the Commission aims to alleviate. Involved are considerations of course content, curricular design, and institutional and student goals. What kind of program will have the vitality and force, the tact and wisdom, the professional competence and organization to aid biology faculties in solving these problems?

Let me organize the remainder of my comments about three topics. First, I want to describe a way of looking at CUEBS' activities and how they interweave with the problems outlined above. Indeed, a weaving metaphor is perhaps the easiest way to speak of a pattern of activity—the designing of a fabric compounded from educational need and Commission activity. Second, I want to stand back from the fabric we are working on so that the larger elements in its design may come clearer. I want to try to find the keys to the design and justify their being there. Third, there is the long-range future of the Commission. The Commission itself is something of a crash program, and as such will eventually have to disappear. But, many of the problems we face now are not unique to our time and to solve them now does not guarantee a final solution. For example, the gap between research and teaching will always need attention. Can the Commission leave a legacy that has the potential of a continuing resourceful attack on the gap and thus assure a minimization at least of that problem for future biologists?

The Pattern of Commission Activity

There are many ways to classify the more than 2,000 different institutions of higher learning in the United States. I will here use a scheme that contains four categories, or ranges of needs, insofar as CUEBS' programs are concerned. First, there are the two-year colleges. These institutions, as you people know far better than I, are in a real sense the unique educational innovation of our times in higher education. This year, in California, of all the students doing first year college work, 70% are doing it in Junior Colleges. The figure is about 50% for Florida and between 40 and 50% for New York. It seems to me two factors give the two-year colleges a peculiar complexity. They are, on the one hand, regional in terms of their impact—they draw locally for their students and the needs of the students reflect local vocational and educational needs. Thus, the colleges differ somewhat from one locale to another. And, in addition, they serve at least five purposes: (a) occupational education, including vocational and technical; (b) adult or continuing education; (c) general education; (d) guidance and counseling education; and (e) education for transfer to a four-year college program. From this

brief enumeration of figures and problems, it is clear that facilities, faculties, and curricula need extraordinarily diverse, but withal imaginative and energetic, attention.

Second, there is the large number of four-year institutions—about 1,200, mostly small institutions, which in most cases are honestly aware of severe deficiencies in their programs and in many cases are working hard to improve themselves. For such readily understandable reasons as lack of funds, inadequate administrative or trustee leadership, problems of regional location, and so on, these institutions simply do not provide the quality of education that is needed today. They need facilities, faculty, money, and ideas.

Third, there is that group of institutions, perhaps as many as 200, ranging from small to very large, which have an as yet unrealized potential. Their slow progress forward is impeded not so much by financial, physical, or personnel deficiencies, but more often, quite frankly, by political problems. The botany and zoology departments can't get together on a program. Biology is taught in five different schools scattered across some square miles of campus. Some members of the department are standing pat—where they have stood, stumping, for too long. And so forth. What's missing at these places? There is no blanket answer for there are only local, unique answers to these local, unique problems. Maybe an outsider can diplomatically release energies at these schools; often he cannot. This group of institutions having some of the finest potential of any, has, in some ways, the most difficult job in finding solutions.

Fourth, and finally, is a group of about 50 colleges and universities that, by almost universal agreement, represent our best in higher education. Their curricular reform matches rather closely the state of the discipline it encompasses; course content is current and usually very well taught; facilities and faculties are good. It is from these institutions that CUEBS draws more than it gives. There are sources for ideas on new introductory courses, on new laboratory projects, on fresh curricular structure and meaningful connections with related disciplines.

In the foregoing categories I have been speaking in generalities and I hope they have been appropriately guarded. For we all realize that important exceptions are present. There are gifted and imaginative teachers active in otherwise weak institutions and the top institutions have their share of weaknesses, too. CUEBS has no intention of being trapped by the superficial neatness of these four groupings and will remain alert to good ideas wherever they can be found.

Next, how do the activities of CUEBS mingle with these four categories of institutions to achieve a pattern of activity. The action arms of CUEBS are its Panels. There are ten of these now and we have authorization for an eleventh which is to be devoted to the problems defined at this conference, i.e., those that pertain to biology in the two-year colleges. There is no time to detail the programs of each panel; let me refer to each one as representing at least one thread—in some cases, depending on their action programs, several threads—that weave in and out of the four institutional threads we have just discussed. Panel activities and institutional needs represent the warp and woof of the fabric with which we are concerned.

I will try to summarize panel activities under general classes of activity and then go to my next major point, which is to see the largest elements in our design. Two panels are concerned with personnel—at the college instructional level and in terms of the college preparation of secondary school biology teachers. Two more are looking at undergraduate preprofessional training in medicine and the agricultural sciences, broadly speaking. One other is to be concerned with the special problems of the junior colleges, as I have just mentioned. The remaining six panels are concerned with the curriculum—its relation to liberal education and to related scientific disciplines, the content of the biology majors' curriculum and testing and evaluating that curriculum; and finally, facilities and instructional materials.

Nature of CUEBS' Activities

The question as to what emerges as the keys to understanding this pattern of activity can be best answered by calling our program prescriptive, consultative and catalytic.

"Prescriptive" is a fighting word among the Commissioners. In the first years of the Commission's existence we bent over backwards to avoid being prescriptive. This stemmed from the obvious fact that biology could be successfully taught in a variety of ways and that CUEBS was in no wise ready to take an authoritative stand as to what was the best way. We have now come to the position that being prescriptive need not be so narrowly defined as referring to only one way of doing things. It can also refer to a level of minimal standards, above which diversity can reign unfettered. We come to this view for the simple reason that it is impossible to teach cellular physiology without certain pieces of apparatus in the laboratory or certain books and journals in the library. And, the same goes for ecology and equipment for field work and references for statistical sampling and identification. One can decide what minimum is necessary for adequate support in a variety of courses." Such a statement, well documented, can be widely used by faculties to bring to the attention of their administrations the specific things that need to be done to up-grade certain programs. And the reverse is also true, that administrations can good logging faculties into action. In this sense of minimal standards we are willing to be prescriptive, and in one other sense, too. We have found that the interface between biology and chemistry, physics, mathematics, and other sciences is notably devoid of good textual materials. We have developed a list of topics—to take the chemistry-biology interface as an example—also an editor, and prospective authors, to prepare a series of paperbacks to fill this need. Commercial publishers will develop the series in consultation with the editor and the authors. Here, then, prescription has taken the form of deciding on an area that needs teaching materials and setting up the program that meets this need.

Consulting covers a wide variety of topics. The essential purpose is to provide careful, individual attention to the peculiar needs of a given department or to develop information needed by a specific panel. It is an obvious device for generating answers where only an informed individual can supply them. We have been able to supply consultants for development of facilities, curricular change and reorientation, and new course programs. And, of course, in addition to the consulting done by individuals representing CUEBS, a kind of consulting can be done by correspondence with the CUEBS' executive office which supplies, on request, information on a great range of information pertinent to biological education.

Finally, there is the catalytic, or more appropriately, if you will, the enzymatic dimension. CUEBS has a finite life span. We do not now know when it will finally expire, but that it eventually will, is clear. The Commission is in many ways an unwieldy way to carry out specific activities. As these specific activities become identified and action taken, we can reduce our panel programs. But in many cases, it is clear, certain activities should go on even when CUEBS is gone. Also, if the biological community comes to expect that CUEBS will take care of certain problems, then with the folding of our program, a source of experimenting and of generating ideas is gone. We must do all we can to leave the biological community with a visible tradition of exploring for new ideas in teaching and with a fund of people experienced in curricular innovation. To this end we are supporting two types of programs. Through conferences addressing themselves to particular problems, such as Biology in Liberal Education, we locate specific issues and the people ready to tackle them. We finance these few individuals to organize their thoughts and energies to the point of seeing a possible course of action and then urge them to apply for outside funds to implement their ideas. Second, we try to locate people who are nationally known for innovative teaching and turn them loose on "pathfinder" projects. Our hope is that giving proven talent the chance to develop ideas outside the restrictions of a given curriculum or other institutional confine, we might turn up really fresh approaches to problems of special concern. . . .

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* Standards for Staff and Facilities in Departments of Biological Science. AIBS Subcommittee on Facilities and Standards. **BioScience** 12 (8): 14-19, 1962

The latter portion of Earl Hanson's article dealt with CUEBS' legacy, and specifically with a proposed resource, development, and training center. Since the development of that concept is part of the detailed history of the Commission, it and the other components of CUEBS' legacy will be discussed in the context of the several major points of focus to which the Commission addressed itself and which were identified in the preceding article.

THE COMMISSION

The Commission was composed, each year, of 26 biologists from various colleges and universities across the country. Two Commissioners (the presidents of the American Institute of Biological Sciences and of the Federation of American Societies for Experimental Biology) served in an ex-officio capacity as did the Director and Associate Director of CUEBS. Commissioners contributed and assessed ideas on college biology instruction and evaluated and assisted the activities of the various panels and committees. The Commission met twice a year (the Executive Committee four times per year) to review current programs and plan subsequent activities.

The 24 elected Commissioners served staggered terms of 3 years, one-third retiring initially at the end of each calendar year, and later at the end of the academic year. The Commission elected new members from lists of nominees presented by AIBS, the National Association of Biology Teachers, the Federation of American Societies for Experimental Biology, the American Association for the Advancement of Science, and other biological or scientific organizations; individual biologists also submitted nominees. A Commissioner served as an individual, neither as a representative of the organization nominating him nor of the one with which he was affiliated.

The following roster of Commissioners reflects the good fortune CUEBS had in obtaining the counsel and experience of the contemporary "Who's Who" in American biology. (Note: in so far as it was possible to ascertain, current addresses are indicated; apologies are automatic for any errors.)

Chairman:

Thomas S. Hall (Washington University), 1963-65
Earl D. Hanson (Wesleyan University), 1965-67
Henry Kaffler (Purdue University), 1967-69
Jerry J. Kollros (University of Iowa), 1969-71

Vice Chairman:

Martin W. Schein (West Virginia University), 1965
Willis H. Johnson (Wabash College), 1966
Henry Kaffler (Purdue University), 1966-67
Donald S. Farner (University of Washington), 1967-69
Arnold T. Towe (University of Washington), 1969-70
James T. Robinson (B.S.C.S.), 1970-71

Commissioners:

(* = those who served at some time as a member of Executive Committee; ** = staff serving ex-officio on the Executive Committee during their tenure): Dana Abell,** State University of New York at Plattsburgh (ex-officio as CUEBS Associate Director, 1968-69); Peter Abramoff, Marquette University (ex-officio as Chairman of the Panel on the Laboratory in Biology, 1967-70); Garland E. Allen, Washington University (1966-68); Ted F. Andrews,** Governors State University (ex-officio as CUEBS Associate Director, 1965-66); David G. Barry,** Evergreen State College (ex-officio as CUEBS Associate Director 1966-67); Richard Beidleman, Colorado College (1967-71); C. Ritchie Bell, University of North Carolina (1967-70); James M. Bennett, New York University-Washington Square College (1970-71); Howard A. Bern, University of California, Berkeley (1967-68); Charles Batticelli, Newton College of the Sacred Heart (1970-71); Richard Bovbjerg, University of Iowa (1963-67); Winslow R. Briggs, Harvard University (1963-66); Martin D. Brown, Fullerton Junior College (1966-69); Peter F. Buri, New College (1964-67); James F. Case, University of California, Santa Barbara (1963-65); Frank M. Child, Trinity College (1963-66); LaMont C. Cole, Cornell University (1966-69); Thomas A. Cole,* Wabash College (1968-71); Lincoln Constance, University of California, Berkeley (1963-65); James F. Danielli, State University of New York at Buffalo (1966-68); Vincent G. Dethier, Princeton University (1967-70); Richard A. Dodge,* Columbia Junior College (1969-71); James D. Ebert,* Carnegie Institute of Washington (1963-66); Paul R. Ehrlich, Stanford University (1968-69); Donald S. Farner,* University of Washington (1966-69); Harold E. Finley, Howard University (1968-71); Sidney W. Fox, University of Miami (1968-71); Lafayette Frederick, Atlanta University (1970-71); Arthur W. Galston (1963-66); Benson E. Ginsburg, University of Connecticut (1963-65); Victor A. Greulach,** University of North Carolina (ex-officio as CUEBS Director, 1964-65); Arnold B. Grobman, Rutgers University (1963-65); Clifford Grobstein,* University of California, San Diego (1963-66); George A. Gries,* Oklahoma State University (1969-71); Thomas H. Hall,* Washington University (1963-66); Earl D. Hanson,* Wesleyan University (1963-67); Garrett J. Hardin,* University of California, Santa Barbara (1968-69); Adolph Hecht, Washington State University (1966-69); James H. M. Henderson, Tuskegee Institute (1967-70); Charles E. Holt, Massachusetts Institute of Technology (1966-68); Johns W. Hopkins III,* Washington University (1967-71); Paul DeHart Hurd, Stanford University (1966-69); Willis H. Johnson,* Wabash College (1963-66); Donald Kennedy, Stanford University (1966-68); Henry Kaffler,* Purdue University (1966-69); Jerry J. Kollros,* University of Iowa (1967-71); Walter A. Konetzka, Indiana University (1963-65); Ray Kuppelman,* West Vir-

ginia University (1966-68); Edward J. Kormondy,** The Evergreen State College (ex-officio as CUEBS Director (1968-71); James W. Lash, University of Pennsylvania (1963-66); Ariel G. Loewy,* Haverford College (1966-68); Robert W. Long, University of South Florida (1970-71); Henry L. Lucas, Jr., North Carolina State University, Raleigh (1967-69); Leonard Machlis, University of California, Berkeley (1966-69); James H. Meyer, University of California, Davis (1966-68); Gairdner B. Moment,* Goucher College (1963-67); David L. Nanney, University of Illinois, Urbana (1966-68); Aubrey W. Naylor, Duke University (1936-66); Clarence H. Nelson, Michigan State University (ex-officio as Chairman, Panel on Evaluation and Testing, 1965-67); Van R. Potter, University of Wisconsin (1968-69); David M. Prescott, University of Colorado (1967-69); Hope Ritter, Jr., University of Georgia (1969-71); James T. Robinson,* Biological Sciences Curriculum Study (1968-71); Thomas B. Roos, Dartmouth College (ex-officio as Chairman, Panel on Preprofessional Training for the Medical Sciences, 1965-67); Anthony San Pietro,* Indiana University (1969-71); Martin W. Schein,** West Virginia University (1963-65 and ex-officio as CUEBS Director, 1965-68); Helen Stafford, Reed College (1968-71); G. Ledyard Stebbins, University of California, Davis (1963-65); William K. Stephenson, Earlham College (1963-66); William L. Straus, Jr., Johns Hopkins University (1963-65); Alfred S. Sussman,* University of Michigan (1966-69); Carl P. Swanson,* University of Massachusetts (1963-65); Charles S. Thornton, Michigan State University (1967-69); Arnold T. Towe,* University of Washington (1967-69); E. Peter Volpe, Tulane University (1969-71); George Wald, Harvard University (1966-68); Val Woodward, University of Minnesota (1969-71); Roy A. Young, Oregon State University (1963-67); and Edgar Zwilling, Brandeis University (1968-71).

EXECUTIVE OFFICE STAFF

The Executive Office staff consisted of a director, an associate director (from 1965-69), and several staff biologists. The professional staff biologists were appointed for one-year terms, usually taking leave from their home institutions to work in the CUEBS' office.

The Executive Office coordinated CUEBS' activities which largely, and especially at first, stemmed from ideas of the Commissioners and various panels and committees. Staff biologists served on panels, helping to plan their activities, gathering materials for their meetings, and assisting in the preparation of their reports. Staff biologists also maintained liaison among the panels, the Commission, and the academic community to whom they increasingly represented CUEBS. In the latter years of the Commission, staff biologists played an increasing role of leadership in generating and executing CUEBS' activities.

Directors:

Thomas S. Hall (Washington University), 1963-64
Victor A. Greulach (University of North Carolina), 1964-65
Martin W. Schein (West Virginia University), 1965-68
Edward J. Kormondy (The Evergreen State College), 1968-72

Associate Directors:

Ted F. Andrews (Governors State University), 1965-66
David G. Barry (The Evergreen State College), 1966-68
Dana L. Abell (State University of New York at Plattsburgh), 1968-69

Staff Biologists:

Dana L. Abell, State University of New York at Plattsburgh (1967 and 1969-71); E. G. Stanley Baker, Drew University (1967-68); Jeffrey J. W. Baker, Wesleyan University (1966-68); Jay Barton II, West Virginia University (1965-66); David Carroll, Honolulu, Hawaii (1965-67); Donald D. Cox, State College of New York at Oswego (1970-71); Joan G. Creager, Northern Virginia Community College (1969-71); Lary V. Davis, Chehalis, Washington (1970-71); Donald S. Dean, Baldwin-Wallace College (1969-70); Ira W. Deep, Ohio State University (1966-67); N. Jean Enochs, Michigan State University (1966-67); Franklin F. Flint, Randolph-Macon Woman's College (1968-69); Willis H. Hertig, West Virginia University (1968-69); Leroy G. Kavaljian, Sacramento State College (1968-69); Edward C. Keller, West Virginia University (1965-66); Darrel L. Murray, University of Illinois at Chicago Circle (1969-70); Thomas G. Overmire, Michigan Academy of Arts, Letters & Science (1966-69); John W. Thornton, Oklahoma State University (1970-71); John D. Withers, Associate Director for Education, AIBS (1969-70); and Donald Wise, College of Wooster (1967-68).

BUDGET

The various projects, programs, and activities of CUEBS could not have been conducted without considerable financial support, namely, some $2.5 million in direct costs, awarded as follows:

Grant Number and Agent	*Dates*	*Total*	*Direct Costs*	*Indirect Costs*
GE1872-Washington University	July 1, 1963-June 30, 1965	194,690	170,260	24,340
GY1-George Wash. University	July 1, 1965-June 30, 1967	550,000	478,352	71,648
Amendment 1	July 1, 1965-June 30, 1967	314,740	313,206	1,534
Amendment 2	July 1, 1965-June 30, 1968	505,700	483,000	22,700
Amendment 3	July 1, 1965-June 30, 1969	404,180	379,933	24,247
GY6787-A.I.B.S.	July 1, 1969-June 30, 1970	560,914	447,440	113,474
Amendment 1	July 1, 1969-June 30, 1972	320,000	251,699	68,301
	TOTALS:	$2,850,224	$2,523,890	$326,334

UNDERGRADUATE MAJOR CURRICULA

Panel members (address at time of appointment): Clifford Grobstein (Chairman), University of California, San Diego; Winslow R. Briggs, Stanford University; Johns W. Hopkins III, Harvard University; Henry Koffler, Purdue University; Walter A. Konetzka, Indiana University; Ariel G. Loewy, Haverford College; Robert H. MacArthur, University of Pennsylvania; John P. Trinkhaus, Yale University; Paul B. Weisz, Brown University (and, ex officio, the chairman of other CUEBS' panels).

After considerable deliberation, the Panel developed the following objectives:

1) To compile and collate curricular content of sample institutions of excellent quality where careful thought has been given to the problem of biology curricula.

2) To extract from these sample curricula a preliminary check list of items generally judged to be central in understanding biology.

3) To test and modify this preliminary list to insure its general acceptability and validity by offering it for expert comment to individuals, institutions, and relevant societies.

4) To publicize the resultant check list among those institutions anxious to have a guide to their own curricular evaluation.

Content of Core Curricula

To acquit these objectives, the Panel initiated a study of the core programs at Dartmouth College, North Carolina State University at Raleigh, Purdue University, and Stanford University. The final report of the Panel appeared as Publication 18, *The Content of Core Curricula in Biology* from which the following recommendations are cited:

The Panel and the Commission approach the problem of recommendations with some misgivings. The resistance of college and university teachers to external dictation of course content is well known and, for the most part, justified. Further the present mood is experimental and hardly warrants pressure toward a conformity which may or may not be eventually desirable. Nonetheless, we cannot resist setting down views we hold at the conclusion of this study for whatever merit and interest they may have.

First and foremost, we recommend early examination of curricula which have not recently been analyzed. The four institutions in our sample have been bellwethers, but the process of curricular evaluation is spreading widely and changes are occurring rapidly. An institution which does not engage in self-analysis is neither fulfilling its scholarly responsibility nor keeping faith with its students.

Second, we recommend that the technique of in-depth analysis be used wherever possible in curriculum examination and redesign. What is important is not the package, but its content. Because an institution does or does not have a given course does not mean it is or is not communicating a particular concept or body of fact. The essential question is whether the student, at the end of his set of courses, is well educated.

Third, we recommend that curriculum analysis and redesign proceed on the assumption that effective teaching requires the expression of the individuality of the teacher and his department. Careful curricular design encourages teacher individuality while insuring that students are well prepared for further professional advancement.

Fourth, we recommend that careful attention be given to relating biology courses to the background of the student in mathematics, physics, and chemistry. In this connection, we recommend that training in biology beyond the introductory course not begin until the student is grounded in mathematics, at least through the level now generally taught as calculus, and has had at least one year of college chemistry. We further believe that students concentrating in biology should have the equivalent of at least one year of physics and some background in physical and organic chemistry.

Fifth, we recommend that the common or core preparation for biologists in any speciality be extended over a minimum of two years. We believe it desirable that this common set of courses be taken in a fixed sequence, so as to allow instructors in successive courses to build logically on what precedes.

Sixth, we recommend that the content of the curriculum be carefully balanced so as to cover what are now recognized to be fundamental biological concepts. These include, at all levels of biological complexity: structure-function relationships; growth and development; the nature of hereditary transmission; the molecular basis of energetics; synthesis and metabolic control; the relationship of organisms to one another and to their environment; and the behavior of populations in space and time, especially in reference to evolution. The relative emphasis placed upon these areas will undoubtedly vary from institution to institution; some may even decide to omit certain of them. Our purpose is to urge that students be made sufficiently aware of the full scope of biology so that they may appreciate the potentials, as well as the limits, of the training they are receiving.

Upon completion of its report, the Panel was discharged and activity shifted to the Executive Office and Commission. In April 1968, a committee was convened to consider appropriate follow-up to the core report. After reviewing several alternatives, the group recommended that CUEBS undertake a study leading toward a new publication which would consist of an expository statement on the concept and philosophy of the core curricula, a new and considerably less detailed master list of items than in the original study, and a collection of annotated syllabi from each of the courses in the core programs. Committee members were David L. Nanney (Chairman), University of Illinois; Donald F. Kennedy, Stanford University; and Thomas B. Roos, Dartmouth College. Martin W. Schein, Director, CUEBS, worked with the panel.

The Context of Biological Education

Upon further and extensive deliberation, the Commission in the fall of 1970 directed that the staff should instead: ". . . identify a representative series of institutions and take a careful look at their programs with respect to several aspects to produce a document reflecting the various alternate good programs at the undergraduate level." With this charge, Staff Biologists Donald Cox and Lary Davis initiated a study which culminated in CUEBS Publication 34, *The Context of Biological Education: The Case for Change*.

At the outset of the study, it soon became evident that selecting institutions on the basis of their having "highly successful and/or innovative" programs in undergraduate biology left the question of trying to decide what it was that made them "good," but more importantly, the charge lacked a context and overview into which observations might be fitted. The staff then approached the study in the context of the following question: "Given the current state of our society, of our institutions of higher education, and of the science of

biology, what should be the goals of biological education in the years ahead."

A total of 20 institutions were visited and in-depth analyses were prepared via an extensive informational questionnaire. The institutions ranged from those ranked as "musts" by 240 biologists whose opinions were solicited to new institutions, some yet in the "drawing board" stage, to two-year colleges developing articulation procedures with "senior" colleges, and to those developing or executing experimental/innovative approaches.

The major conclusions of this study are as follows:

1) Without adequate planning, it is impossible for any organization to function effectively. To this end, every biology department should engage all its members in a continuing dialogue aimed at determining what its goals are, the resources it has available, and the manner in which these resources can best be used to reach these goals.

2) In most biology departments, decisions on curriculum matters are made primarily on the basis of personal opinion. All too often they contain a number of highly dubious assumptions about the needs of students or the nature of the learning process. To help correct this situation, institutional research programs are needed to ensure that (a) more useful information can be obtained about in-coming students, and (b) planned or existing instructional programs can be evaluated more objectively.

3) Inflexibility imposed by college calendars and lengthy lock-step curricula are major problems in current biological education. The educational function would be more effectively served if these were modified to: (a) relate college calendar time units to the needs of learning programs; (b) facilitate mobility and the tailoring of individual programs; (c) accommodate students who need to "stop-out" for periods of work or for other reasons, and members of the working force who wish formal educational experiences.

4) Associated with the need for loosening the structural rigidity of biological education is the equally pressing need for the reconsideration of teaching methodology. The traditional lecture-laboratory format should be reassessed and alternative forms of instruction developed in order that students may become more active participants in the learning process rather than passive recipients of a predetermined and prescribed body of information. Students should have more experience with the processes by which biological information is generated, even if this means less "coverage" of biological information.

5) Current degree programs in biology unnecessarily isolate students from contact with the real world. Learning programs are needed which allow students to stop out at various points to engage in some form of actual employment or service experience outside the confines of the academic community.

6) The primary criterion for advancement in rank or for salary increments in many biology departments has traditionally been research productivity. This has often resulted in a casual attitude among staff members toward teaching responsibilities. To counter this there is a great need for the development of means for the objective evaluation of teaching and for a reordering of priorities so that good teaching is rewarded on a par with research productivity.

Miscellaneous

"Towards a New College Biology" and "Roots of Change" were the titles of two book projects undertaken by staff biologist Dana Abell from 1969-71 who was permitted to reside on the Earlham College campus to facilitate development of the manuscripts. Neither project was completed.

BIOLOGY IN A LIBERAL EDUCATION

Panel Members (address at time of appointment): Peter F. Buri (Chairman), San Francisco State College; Garland E. Allen, Harvard University; Harriet B. Creighton, Wellesley College; Earl D. Hanson, Wesleyan University; Charles Heimsch, Miami University; Gairdner B. Moment, Goucher College; Carl P. Swanson, Johns Hopkins University.

The panel, early on, determined its objectives as follows:

1) Study the feasibility of designing and subsequently trying out a general biology course which emphasizes how biological information is obtained and conclusions verified.

2) Develop ideas for an integrated basic science course incorporating biology, physics, and chemistry in a two-year program.

3) Undertake a pilot study in the philosophy of science as to the nature and structure of biology (to help discover ways of more effectively presenting biology to liberal arts students).

Among the Panel's major recommendations was one of support of the laboratory as integral and indispensable for nonmajor students; it also recommended upper division courses without hierarchy of prerequisites for such students. The Panel also debated the question of whether there should be a single course for majors and nonmajors combined or whether there should be separate courses for each. The consensus (not unanimous) was that there should be a single course for majors and nonmajors—not separate courses.

However, there were three specific reasons given for this recommendation.

1) When a separate course for nonmajors exists side-by-side with a course for majors, the former often becomes a watered-down version of the latter.

2) Should a student in the nonmajors course become interested and wish to become a biology major he must then take the introductory course for majors his sophomore year.

3) Many small colleges simply do not have the staff or facilities to offer two different introductory courses.

Having decided on one course for majors and nonmajors, the Panel then sponsored a colloquium at Stanford University in August 1965. To this colloquium were invited approximately two dozen biologists who had shown considerable interest in the area of introductory biology. It was hoped that their interaction with each other would produce outlines of highly imaginative and innovative introductory biology courses.

Biology in a Liberal Education

Approximately 20 papers dealing with philosophy, content, etc., of their proposed courses were submitted by the

Stanford Colloquium participants. CUEBS Publication No. 15, *Biology in a Liberal Education*, was the result. The following excerpts are from that publication:

> The diversity of ideas and convictions expressed by the Stanford Colloquium participants might lead to the conclusion that virtually any kind of biology course could be justified for a liberal education. However, if this report seems to emphasize disagreement more than agreement, it is perhaps because I leaned over backwards in order to insure that minority viewpoints were not ignored. In truth, there were discernible consensus on many major points concerning what a biology course in a liberal education should and should not be. For example, the inquiry approach to science, stressing the "process" of science (i.e., the underlying logic of the scientific enterprise) received strong support, and the need was expressed for more of this in our lectures, laboratories, and course materials. . . .
>
> What, then, did the Stanford Colloquium accomplish? By itself, possibly little. Viewed in broad perspective, however, its accomplishments are significant. Forced to explore many avenues of attack on the problem of biology in a liberal education, a few participants felt that the Colloquium had clearly identified those which were dead-ends. These persons also felt that existing avenues which showed promise had been marked, and new ones opened. The Colloquium also may have led the way to a fresh consideration of still unanswered questions. Is BSCS a college level approach in the high school and, if so, is this appropriate? Do college and high school students learn best in the same way? Presumably there is agreement on biology having a theoretical unity. Why, then, don't we have agreement on how to teach it? Is it because theoretical unity as a discipline has little to do with learning? Perhaps the main difference is merely the teacher's personality. If so, should we perhaps discuss the pertinent features here and not theoretical unity?
>
> What about familiarity with modes of inquiry? Can we find a way to impart this outside of the laboratory? How do students learn best? Should we not determine this first, and then adapt our materials accordingly? These and other such questions must be answered if any meaningful attack on the problem of biology in a liberal education is to be made; at Stanford the groundwork for answering at least some of these questions was begun.

Explanation in the Biological Sciences

With the completion of this publication, the panel was discharged and further activity was generated by the Executive Office and Commission. First, a Committee on the Structure of Biology to examine the implications of that structure on the teaching of biology was formed. It was comprised of Garland Allen (Washington University), Dudley Shapere (University of Chicago), and Everett Mendelsohn (Harvard University). The Panel conducted a symposium, "Explanation in Biological Sciences: Scientific, Philosophical, and Historical Aspects," June 7-11, 1968, at Asilomar, California. The conference presentations appeared, in complete form, in the *Journal of the History of Biology*, Vol. II, No. 1 (Spring 1969). The conference was organized around three major topics:

1) Uniqueness and change in biological explanation
   - Explanation and theory in biology: some philosophical problems
   - What biological explanation looks like today
   - Revolution and evolution in biology
2) Some questions about specific alleged factors of uniqueness in biological explanation
   - Teleology and Teleonomy
   - Historicity, uniqueness of events, and predictability
   - Organizational levels and adaptive explanation
3) Organism, environment and intelligence as a system

An attempt to "translate" the proceedings from the level of the philosopher to the biology teacher was undertaken by Staff Biologist L. Kavaljian working with Dudley Shapere. This project was never completed.

Biology for the Nonmajor

Next, on November 10, 1966, a letter went out to over 100 persons from the research, administrative, and instructional levels of biology, as well as scientists from related fields, asking their opinions concerning the content and philosophy of an ideal biology course to be taught to college juniors or seniors already majoring in the humanities or social sciences. An upper-level course was specified in order to free the writers from feeling they had to include material traditionally considered "necessary" for any potential majors to have in an introductory course intended to prepare them for further work. The letter also asked specific questions concerning problems to which it was hoped the persons receiving the letter would direct their attention, i.e., Should there or should there not be a laboratory?, Should the course avoid being molecular or should it include molecular biology?, etc. The same 60 replies were summarized in CUEBS Publication No. 19, *Biology for the Non-Major*.

There were several outstanding trends in the recommendations concerning the content of the proposed course. Foremost among these was a strong concern for human biology—that portion which deals with matters of interest to man (e.g., population control, pollution, etc.). It was felt, however, that this material should be introduced in such a way that the student does not get the impression that biology exists simply to solve man's problems.

Considerable attention was given the concept of an "in-depth" approach to biology. It was felt that it is no longer possible to cover all of modern biology in a one-year course, be it for majors or nonmajors. (As one participant put it, "to strive for coverage is to strive for the impossible.") Therefore, it was recommended that certain segments of biological subject matter be selected and covered in greater detail. It was felt, in general, that choice of the segments should be left up to the instructor's particular interests and competencies. Two persons suggested that the BSCS idea of a laboratory block might be adapted to a college-level course of this type.

Tremendous interest was shown by the vast majority in integrating the biology course content with its philosophical and historical implications. In line with this thinking, the relation of biology to other disciplines was another point discussed by the respondees. It was felt that the course should be designed to provide nonmajors with a broader base from which they might interpret their own special areas of interest.

One point on which there appeared to be virtually unanimous agreement, both at the Stanford Colloquium and among the letter writers, perhaps was expressed best by the following quote:

> No specific facts of biology or any science are absolutely requisite. What is most important for the education of students in science is the nature of scientific statements and the way in which this information is gained. Of course the study of how information is obtained cannot be

taught *in vacuo*. Information, the content of science, must be taught in a rigorous way. But the organization of the course should reflect the more important goal: the introduction of students to what scientists do by the practice of science itself.

Bar Harbor Conference

As a final formal project aimed toward the nonmajor, CUEBS sponsored a Conference on Biology for the Non-Major at the Jackson Laboratory, Bar Harbor, Maine, September 8-9, 1967. Participants were persons who either had taught, were currently teaching, or were planning to teach an upper-level biology course for the nonmajor.

Outlines of upper-level courses for nonmajors were presented for discussion. The courses varied widely in both content and philosophy and demonstrated participants' willingness to go far beyond the bounds of the traditional introductory biology course in order to include material more relevant to the nonscience major.

Since some of the participants were among those whose ideas were compiled in *Biology for the Non-Major* (CUEBS Publication No. 19), it was perhaps natural that many of the conference discussions lent strong support to the ideas and philosophy reflected in this publication. For example, once again a strong emphasis on human applications of biology was evident in many of the course outlines. Most participants felt it extremely important that students understand man's relationship to his living and nonliving environment and the pertinence of this relationship to social and socio-economic problems.

Some interesting new points were raised, however. It was noted that many problems inherent in establishing innovative courses lie in the "political structure" of a biology department. Seemingly, a department's younger members feel a need to "flex their muscles" concerning their biological "knowledge," and they insist on rigorous, discipline-oriented courses. However, an experienced professor usually is more tolerant of his student's ignorance and less inclined to try to impress students with his cognizance of the field.

Many participants felt that a laboratory was not essential in a course for the nonmajor and suggested discussion periods as an effective substitute. Others disagreed, but stressed that laboratories offered the nonscience major should be "open-ended . . . , allowing him to see the means by which scientific data is gathered, analyzed and reported."

Concerning evaluation, it was pointed out that biology professors who profess to emphasize the nature of scientific investigation in their courses, rather than the rote memorization of facts, must avoid testing students solely for factual recall. Examinations and tests must reflect the main philosophy of the course, since students tend to aim their study techniques accordingly.

The Bar Harbor Conference participants showed a remarkable willingness to consider student interests when structuring their courses. It was felt that this could be done without necessarily perverting the discipline. The need for more adequate student feedback and better faculty-student communication was also discussed. Several ways of obtaining feedback were suggested: e.g., weekly meetings with lab instructors (usually graduate assistants who are nearer the students' age group); discussions in adult education courses (where students are older and tend to be less reluctant to criticize); and feedback from particularly bright students who make no bones of hating science and who speak frankly —and often validly—of the irrelevance to them of many science courses offered nonmajors.

Considerable discussion concerning the nature and purpose of a liberal arts education led to some questioning of the desirability of requiring certain liberal arts courses for all students. Some participants noted that having no required courses would eliminate the problem of dealing with captive students in our classes. It was also suggested that the early University of Chicago system (in which all courses were required) might be advisable, since a student would enter such an institution only if he agreed essentially with its program.

One participant had done an informal survey in *American Men of Science* and discovered that (1) of the biologists listed, many had not been biology majors in college, and (2) many Nobel Prize recipients were not trained at the undergraduate level in the field in which they were awarded the prize. Indeed, two or three of the Bar Harbor conference participants now offering highly imaginative courses received their bachelors' and even masters' degrees in other fields. Many felt this tended to refute the rigid, discipline-oriented training we now consider necessary to the biology major's education. In other words, the participants seemed to feel that the closer we come to the true philosophy of a liberal arts education (i.e., broad training in related—and even seemingly unrelated—areas), the closer we will be to producing well-rounded citizens on the one hand and excellent scientists on the other.

BIOLOGY IN THE TWO-YEAR COLLEGE

Panel Members (address at time of appointment): David G. Barry (initial Chairman), State University of New York at Albany; Martin D. Brown (second chairman), Fullerton Junior College; Alfred Chaet, University of West Florida; James M. Ford, Skagit Valley College; Alvin R. Grove, Pennsylvania State University; Mary Ann McLanathan, Foothills College; J. Clyde Driggers, Abraham Baldwin Agricultural College.

The charge to the panel was to give special attention, with reference to the two-year college, to: biology curricula; quality of instruction; liaison with four-year institutions; preparation of instructional personnel and biological facilities. Three curricular programs of special concern were identified

as: (1) adult and continuing education; (2) technical education; and (3) general education of vocationally oriented students.

Biology in the Two-Year College

The panel's report appeared as CUEBS Publication 26, *Biology in the Two-Year College*. The recommendations of that report follow:

1) Biology majors should complete all necessary lower division courses in chemistry, physics, and mathematics before transferring; hence, two-year college biology departments should limit their course offerings beyond introductory biology.

2) Since articulation problems are local, they must be solved at the local level. Communications between biologists of two- and four-year colleges should be in terms of content elements rather than course titles or general course outlines.

3) The issue of separate courses for nonmajors should be settled by each institution, taking into account local conditions, needs, views, and capabilities. Individuals debating the issue should do so as individual biologists, not as representatives of two-year colleges.

4) Two-year college biologists and specialists in biology-based occupational programs should identify groups of related bio-occupational programs and should construct content blocks of biology appropriate to each group. These blocks should be taught by biologists, while the applied components should be taught by bio-occupational specialists.

5) Two-year college biologists should actively seek to incorporate in the general education requirements an appropriate educational experience in biology for the nonbiology occupational students.

6) Programs designed especially for the training of two-year college biology teachers are untenable and should be discontinued.

7) Two-year college biologists should utilize their keen awareness of the need for adequate pedagogical training to help mobilize programs that apply to all college biology teachers.

8) A national committee with representatives from such organizations as the several College Commissions, the American Association for the Advancement of Science, the American Institute of Biological Sciences, the American Association of Junior Colleges, the American Council on Education, etc., should be formed to study institutional problems which bear heavily on the effectiveness of undergraduate education in the sciences in two-year colleges.

9) The Commission on Undergraduate Education in the Biological Sciences/American Institute of Biological Sciences (CUEBS/AIBS) should appoint a study group to investigate in detail the working conditions of the two-year college biologist. They should formulate from their study appropriate recommendations and designate action arms for broadcasting and implementing their recommendations.

10) The American Institute of Biological Sciences (AIBS) should appoint one or more study groups to consider the concept of clustering bio-occupational programs and developing content blocks of biology appropriate to each cluster; questions of training and recruiting specialists to staff the applied components of bio-occupational programs should also be considered. AIBS should take the necessary steps for implementing recommendations arising from the study groups.

11) CUEBS should initiate and guide efforts to sponsor one or more local conferences with the purpose of constructing appropriate models for effective, ongoing articulation between two- and four-year institutions.

12) The various professional biological societies under the leadership of the American Institute of Biological Sciences should develop vigorous programs designed to engage two-year college biologists in truly professional activities in the biological community.

Conference on Science in the Two-Year College

With the preparation of its report, the Panel was dissolved and the directive activity then shifted to the Executive Staff, largely under Staff Biologists Willis Hertig, John Withers, and Joan Creager successively. The eighth of the panels' recommendations was implemented by CUEBS in 1969 when 32 representatives of 17 national scientific and educational organizations convened in Washington, D.C., for a "Conference on Science in the Two Year College." The groups represented were: American Association for the Advancement of Science, American Association of Junior Colleges, Advisory Council on College Chemistry, American Council on Education, American Chemical Society, American Geological Institute, American Institute of Biological Sciences, American Institute of Physics, Commission on Education of the National Academy of Engineering, Commission on Undergraduate Education in the Biological Sciences, Council on Education in the Geological Sciences, Committee on the Undergraduate Program in Mathematics, Mathematical Association of America, National Faculty Association of Community and Junior Colleges (representing the National Education Association), National Science Foundation.

The specific consensus of recommendations, several of which were reached without unanimity, were distributed to the conferees for transmittal to their respective organizations for endorsement and implementation. By late spring 1970, the endorsed guidelines, with a supporting rationale, were disseminated widely to regional accrediting associations, professional organizations, two-year college administrators, teachers, and so on, for further implementation and to serve as a basis for continuing dialogue among groups concerned with science in two-year colleges.

Among the statements developed which dealt with curriculum, it was recommended that the two-year college science faculty itself play the dominant role in designing and evaluating a variety of innovative curricula and courses to prepare students for both upper division courses at four-year institutions and specific occupational programs; further, that occupational programs be the joint concern of the science faculty and the occupational program faculty to effect maximum coordination and transfer of skills and concepts from course to course. Two-year colleges, through their science faculty, were encouraged to establish articulation arrangements with four-year colleges to facilitate transfer of students. Four-year colleges were encouraged to offer courses which facilitate a smooth transfer of the two-year college student and to evaluate carefully and accredit students whose curricular program may have deviated significantly from conventional transfer programs. College guidance and counseling personnel were encouraged to work closely with science faculty to assure proper placement, as well as goal-orientation, of the student.

On the matter of standards and licensing, it was recommended that accreditation of two-year college graduates be based on an individual's competence rather than specific curricular standards, that the approval of particular curricular programs be primarily a faculty and institutional concern, but that institutional and vocational accreditation should remain within the province of regional accrediting agencies.

Each university science department was encouraged to accept responsibility for the preparation of two- and four-year college teachers; the preparation of the two-year college science teacher should include a teaching experience super-

vised by a science department, preferably in a two-year college. It was also recommended that the master's degree in the teaching discipline serve as the minimum academic preparation for the two-year college science faculty and that additional preparation stress breadth as well as depth.

Regarding teaching load, it was recommended that appropriate professional societies or agencies, reacting to the trend of the times, assume prime responsibility for defining faculty loads within their own disciplines and that these be based on number of contact hours, student loads, availability of support personnel, etc. It was also recommended that secretarial and technical supportive personnel be made more readily available to two-year college science teachers by their administrations, and that research (both scientific and pedagogic) and affiliation and active participation in the affairs of professional societies be encouraged and facilitated. Faculty should have a voice in such internal personnel policy matters as those relating to academic rank, salary, promotion, hiring, and dismissal.

Professional growth was encouraged by recommendations for a sabbatical leave policy and for local and regional in-service programs, industry-sponsored internships and fellowships, and continued governmental support of national in-service institutes which stress lower division subject matter and its teaching.

It was recommended that, throughout the entire educational system and through appropriate governmental agencies and professional societies, means be provided for a continuing dialogue on science in the two-year college and that two-year colleges themselves take the initiative in reform and reconstitution of their educational programs. It was also recommended that a guide to funding agencies appropriate to two-year college science be developed.

National Task Force of Two-Year College Biologists

In response to the Panel's 9th recommendation, CUEBS and the AIBS office of Biological Education established a National Task Force of Two-Year College Biologists with the following members: Evelyn M. Hurlburt (Chairman), Montgomery College; Richard A. Dodge, Columbia Junior College; Richard B. Glazer, Ulster County Community College; Arnold J. Greer, Merramac Community College; Stanley E. Gunstream, Pasadena City College; Terrance L. Higgins, Wesley College; Fred Ross, Delta College; Gayle M. Weaver, El Centro Junior College; John Zaharis, Miami-Dade Junior College. In addition to sponsoring symposia at the AIBS Annual Meeting and conducting local and regional articulation conferences (Recommendation 11), a major output of the Task Force was an in-depth profile of the two-year college biologist. This study was conducted by Joan Creager, based on a questionnaire returned from 1,164 biologists in two-year colleges. A preliminary report of the study appeared in the October 1970 **CUEBS News** and the full report was published in *BioScience* (1971), **21**: 124, 129-135.

The Panel's 10th recommendation recognized the need for programs designed to train the personnel to fill the "middle manpower" needs in life science technicians (estimated to be 109,000 in 1980 as against 70,000 available in 1963). This resulted in project BIOTECH, a joint development of CUEBS-2YC program (notably via Staff Biologists Willis Hertig and John Withers), the AIBS Office of Biological Education, and the AIBS BioInstrumentation Council. This project was subsequently funded by the National Science Foundation and is currently underway. It will not be a prescriptive teaching program but rather will provide a pool of teaching modules from which the instructor may select to suit program needs. These modules are skill rather than concept modules and will be self-contained, independent, instructional units designed to accomplish the task of teaching someone "how to do something."

LABORATORY IN BIOLOGY

Panel members (address at time of appointment): Peter Abramoff (Chairman) Marquette University; David G. Barry (initial Chairman), San Jose State College; Charles E. Holt, Massachusetts Institute of Technology; Arthur Houston, Marquette University; Louis Wilcox, Earlham College; Val Woodard, University of Minnesota.

The panel was charged with clarifying the function of the laboratory in the changing biology curiculum and presented its position paper in CUEBS Publication 28, *Investigative Laboratory Program in Biology*, which appeared in *BioScience*, **19**(12), December 1969: 1104-1107.

Position Paper

It was the opinion of the Panel members that, while there will always be a variety of valid ways to design the laboratory experience, "the best use of the laboratory in undergraduate instruction is to engage the student in the process of active investigation." This conclusion was reached after a thorough consideration of the objectives of laboratory instruction. They identified several roles that have been traditionally assigned to the laboratory; these are: (1) the illustration of objects and experiments that have been introduced elsewhere in a course; (2) the provision of training in laboratory techniques; (3) the intellectual stimulation of the student and the development of an appreciation for biology and for living things; and (4) the creation of an environment for a discussion of the many facts and ideas that arise from working with organisms and experiments. Each of the above can contribute to, and be drawn from, the laboratory experience, but the Panel felt that the primary role of the laboratory is to engage the student in scientific investigation.

Several lines of thought led to this conclusion. First, the

investigative origin and rapid rate of change of biological knowledge make it essential that biologists stress the processes by which the content of our discipline is generated and changed. Second, science curricula should be planned to provide for increasingly complex inquiry activities as students progress from elementary school to college. Third, investigation provides considerable possibilities for individualizing instruction, and finally, from a cognitive point, investigation provides the opportunity to develop creative and critical abilities in complement to the powers of comprehension and memory stressed by traditional content-oriented pedagogy.

When biology is taught with the conviction that it has relevance to the student throughout his life, it is not enough to teach only the concepts, generalizations, and theories of the science. The student must be made aware of the attitudes, decisions, meanings, strengths and limitations, and values embodied in biology. The members of the Panel argued that these attributes are "associated more with the processes of the science—with its modes of generation—than they are with its theories and generalizations."

In addition to some of the advantages inherent in investigation, the members of the Panel reported other advantageous effects not previously predicted. They stated that "a notable effect has been a rekindling of faculty interest in teaching. As a result, much longer and more stimulating contact with students has been noted. It is especially notable that assignment to investigative laboratory activities is frequently regarded as a prestigious activity. . . . Thus, the investigative laboratory can provide the vehicle for more informal student-faculty interactions of the type increasingly sought by our undergraduates."

Staff Biologists Dana Abell, Darrell Murray, and John Thornton gave considerable to exclusive attention to carrying forward the laboratory project after the panel had developed its position statement. Abell contributed particularly to completing the aforementioned position paper, Murray to identifying innovators and innovations and conducting a major summer workshop, and Thornton to developing the materials which resulted in CUEBS Publication 33, *The Laboratory: A Place to Investigate* (April 1972).

Summer Workshop

The summer workshop was held June 15-July 10, 1970, at Marquette University, and was directed by Robert Thomson, of Marquette, aided by members of the Marquette Biology Department. Ten college and university level teachers came not only to exchange ideas but to develop investigative materials for use in their own teaching activities. Following a role-playing exposure to the Marquette procedure for introducing students to investigation, and to in-depth discussions of the nature and activity of investigation, they pursued the individual investigations to the end of developing investigative laboratories for their own campuses. Some investigations were completed, others not. Some were subsequently used by the participants and reported in **CUEBS News** or in Publication 33; others were not put into practice according to follow-up inquiry. That the concept, rationale, and mechanics of the investigative laboratory can be transmitted to teachers (i.e., that they can learn to be teachers of investigative laboratories) was confirmed by the workshop.

The Laboratory: A Place to Investigate

During the final active year of CUEBS, Staff Biologist John Thornton devoted full time to the laboratory project with the objective of collecting and collating a wide variety of investigative laboratory activity into permanent form in Publication 33. This compendium of information covering introductory and advanced courses, two and four-year colleges, field stations, as well as guidelines, rationale, and philosophy of the investigative laboratory approach must certainly rank as one of the most significant products of CUEBS' activity.

INSTRUCTIONAL MATERIALS AND METHODS

Panel members (address at time of appointment): Frank M. Child (Chairman), University of Chicago; Donald H. Bucklin, University of Wisconsin; William S. Firshein, Wesleyan University; James W. Lash, University of Pennsylvania; S. N. Postlethwait, Purdue University; Clarence Taft, Ohio State University; and Paul B. Weisz, Brown University.

MIDPRO Conference

The first activity of this panel was the MIDPRO Conference (Materials Identification and Development Project) held at Dartmouth College, June 22-July 17, 1965. The intent of the conference was the production of instructional packets on photosynthesis, plant growth and development, animal development, and population ecology. Seventeen college biologists participated in the conference toward the end of developing laboratory experiments and/or learning packets. None of these materials reached fruition as published products by CUEBS, although a laboratory exercise in community ecology received wide dissemination via informal routes.

TACHYPLANT Project

The Panel's "tachyplant" committee completed an analysis of a questionnaire concerning plants with a short life cycle suitable for laboratory study. This analysis was published by S. N. Postlethwait and Staff Biologist Jean Enochs as, "Tachyplants—suited to instruction and research" [*Plant Science Bulletin*, **13**(2): 1-5]

Center For Biological Education

The Panel's major effort was toward the establishment

of a Center for Biological Education. In their report, the Panel noted:

> Our analysis of the condition of the college biology teacher has led us to the conviction that the community of biology instructors needs a National Center of Biological Education which would be a depository for new instructional materials and for excellent, but not well-known, existing materials. The Center would give information in response to a phone call or written request from any instructor who is planning to change his courses. The Center would send samples of books, written directions, living material, etc., to the instructor, so that his needs could be met within the limitations of time and money at his disposal. The Center would dispense information and samples of materials to the inquiring instructor in a form which would challenge and develop his ability to discriminate among, select, and judge the worth of the materials for his purposes. The Center will require of its clients that they send back to the Center information on the failures and successes they experience with the materials sent to them. In this way, the Center will be able to provide other instructors with evaluations and criticisms of the materials. The Center might be said to be a permanent seminar of instructors of undergraduate biology, a never-ending seminar, whose participants will learn in proportion to the extent they participate, who will always be assured they have among their numbers the nation's best teachers, and who will always be assured they have access to the very best teaching materials the nation has at hand.
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> The Center will be operated by a director and a staff of biologists who will concern themselves with the impact of modern biology on curriculum and on instructional materials. The biologists will respond to requests by providing samples of materials of various kinds, ranging from suggestions on how to present a single lecture topic, through laboratory exercises of varying difficulty, to syllabi and materials for whole courses. In order to provide this information rapidly, the Center must be well organized and efficiently operated. This will require the services of a staff of librarians, archivists, or bibliographers, versed in the technology of information storage and retrieval. The Center will receive the results of the use of the materials by requiring written evaluations from the teachers. These evaluations will be stored with the relevant materials and will be available to other teachers. These operations constitute the Center's primary activity, and the sine qua non of its existence.
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> In spite of the emphasis which the Center would give to the informational aspects of its activity, other functions of the Center might include training and updating college biology teachers by means of short courses, summer programs, or symposia; publication of a newsletter and resource letters; the development of new materials and methods. The Center might become a focus of discussion and research in biological education, much as the Marine Biological Laboratory, at Woods Hole, has been a focus for biological research.
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> The Panel views the Center for Biological Education as unique in several ways: (1) it focuses on the college level; (2) it focuses on a single major scientific discipline; (3) it provides for the continued storage, evaluation, and availability of the best teaching materials the world possesses; (4) it provides each teacher in the nation with an organization through which he can inquire, make requests, and seek advice; and (5) it provides a new kind of mechanism, a kind of permanent seminar, which ought to increase communication and flow of information among the nation's teachers of biology.
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> The Center is envisaged as a comprehensive organization designed and operated so as to provide materials related to all aspects of biology teaching, for a variety of types of students and institutions. It is anticipated that the Center would be an independent corporation governed by a Board of Trustees and administered by a Director. The activities of the Center could be organized under four departments: (1) Department of Requests; (2) Department of Storage and Retrieval; (3) Department of Evaluations; and (4) Department of Extensions.

In July 1967, Donald H. Bucklin, of the University of Wisconsin and a member of the original Panel on Instructional Materials and Methods, accepted a one-year consultantship to conduct a feasibility study of the Panel's major recommendation, namely, that the Commission should seek ways to encourage the development of a Center for Biological Education. The Center would be based on the assumptions that (1) the best instructional materials are scattered over a diverse literature that is minimally available to the average college biology teacher, and (2) facilitating identification and distribution of these materials can do much to help college biology teachers improve their instruction. It was hoped, too, that teachers would be encouraged to undertake a Center-aided program of continued self-renewal. Modern communications technology would be employed to store and rapidly distribute student-usable printed materials supporting all aspects of either general or core biology courses.

Dr. Bucklin submitted his completed report in late August 1968, reporting favorably upon a microfilmed storage and retrieval system that would supply short excerpts from textbooks, monographs and manuals, or abstracts of films in response to specific questions on content from biology instructors. The service would be offered on a subscription basis and would be designed to encourage the college teacher to keep himself alive to his subject by taking over much of the job of course revision for himself.

Dr. Bucklin's extensive report served as a base for design of a second type of Center which was developed by Dana L. Abell, of the CUEBS Executive Staff. This second type of system would be less dependent upon specialized equipment and would revolve around a large subject guide to the contents of recent texts and of a basic set of library materials. Additional reference materials would be drawn from the Center itself by means similar to those envisioned by Bucklin. The total package, which combines several additional services, would be quite similar in function to Bucklin's Center but would be accomplished by coordinating services, capabilities, and active interests that already exist.

The third step would be the preparation of a set of proposals for funding a Center which would follow the lines recommended in this second report. One proposal would seek funds for a study of the potential user of such a Center; another would be aimed at the development and trial of the indexing system; a third would seek funds to begin coordinating trial operations of certain key elements of the information system. Private corporations, professional societies, universities, and governmental agencies may all find appropriate roles in the operation of the Center and in the information system it would be designed to foster.

The Executive Committee then directed that specific plans and proposals for funding be developed by the Executive Office. Dana L. Abell was assigned this responsibility in mid-1969. Several drafts of a proposal were prepared and reviewed by the staff and the Executive Committee between then and October 1969 when a tentative proposal was submitted to the National Science Foundation for informal review. In March 1970, an interim Steering Committee was established consisting of the following: Henry Koffler, Purdue University (Chairman); Ted F. Andrews, Governors State University (first Chairman); Nathan Cohen, Uni-

versity of California, Berkeley; Richard Dodge, Columbia Junior College; Charles Lytle, North Carolina State University; James Robinson, BSCS; Anthony San Pietro, Indiana University; and Alfred Sussman, University of Michigan.

A final proposal was submitted to the National Science Foundation, having AIBS as fiscal agent, in October 1970, with the purpose of developing products that would bring research laboratory knowledge into a useful form for the classroom teacher. The components of this product orientation were seen as: (a) bibliography of secondary sources of literature; (b) index of secondary sources; (c) master item list; (d) basic topics list; (e) condensations of technical reviews; and (f) a newsletter. A number of sites for the Center were actively considered and Purdue was recognized as the preferred site, and an interim Director, Dana Abell, was appointed. Upon failure of the proposal to receive support from NSF, and with the lack of sufficient unallocated or unencumbered funds in the CUEBS budget for 1971-72, the Center Steering Committee recommended to the CUEBS Executive Committee that further efforts toward establishing such a Center be terminated at least until the National Science Foundation had a clearer idea of an interdisciplinary center which it has been considering.

Module Project

CUEBS' concern with modularized instruction evolved from an interest in audio-tutorial laboratories which extends back several years. At the Purdue Audio-Tutorial Systems Conference held in October 1969, several biologists began to turn their attention from A-T to the question, "Where do we go from here?" In an attempt to clarify some of the new directions taking shape in biological education, CUEBS sponsored two conferences in June 1970; the first was held in Denver and the second, at Purdue. The central focus of these conferences came to be the use of modules in college biology teaching, since nearly all of the participants in these conferences were engaged in developing some form of individualized, modularized instruction.

The time was ripe for the shift in attention from the audio-visual method to the broader concern with modules. The Purdue Minicourse Project was being launched and members of the AIBS/CUEBS staff were awaiting an answer from the National Science Foundation concerning their proposed Project BIOTECH. (BIOTECH has subsequently been funded.) Staff members at Kansas State Teachers College, Columbia Junior College in California, and South Dakota State University all had their own styles of individualized, modularized instruction operating in their departments.

About 15 biologists attended the conferences, including representatives of all of the above mentioned programs and projects. The significant accomplishments of the conferences were the derivation of a tentative definition of a module and a list of major components included in a module. Although the manner of presentation of modules varies among the different programs, there seems to be general agreement that modules usually contain most of these basic components: (1) statement of purpose; (2) prerequisite skills; (3) pre-test; (4) instructional objectives; (5) implementers; (6) modular program; (7) related experiences; (8) post-test; and (9) evaluation of the module.

After the conference, Darrell Murray, then a CUEBS Staff Biologist, began to put together a collection of papers which would define modules and their components, describe some modularized programs, and provide examples of some modules. What was originally thought of as a special issue of **CUEBS News** devoted to modules evolved into Publication No. 31, *The Use of Modules in College Biology Teaching*. The conference participants are listed in the publication and the introductory articles are devoted to a discussion of the components of modules and some of the advantages they provide for students, teachers, and institutions. A variety of modularized programs are described and several examples of modules are provided.

While the publication was taking shape and articles were being collected from various people involved in modularized instruction, staff discussions were becoming increasingly focused on student-centered education. We came to see modules as a powerful tool for creating student-centered educational experiences. Although not the only means to this end, modules do provide a means for individualizing instruction, for allowing students to progress at their own rate, and for offering a great variety of options to the student as he plans his own educational program. One of the potential dangers of modularized instruction also received much discussion. That danger was the possibility of grinding out modules for independent use by students and failing to provide the other important components of teaching that only teachers can provide. As the learning process becomes increasingly modularized, the teacher is increasingly freed from the preparations which have taken so much time in the past. The teacher is in a position to devote more time and effort to help students appreciate the meaning and relevance of what they are learning, to show students that he cares about each of them as individuals, and to provide opportunities for creative expression.

Although the module publication provided written descriptions of modules, modular programs, and the ensuing changes in the role of teacher, it seemed desirable to bring groups of teachers together face-to-face to explore the use of modules. A series of three 2-day workshops, called "Minicourses on Modules," was arranged. Each had its own unique atmosphere. The content varied from one minicourse to the next according to the particular setting, the facilities available, and our own modifications of the program based on past experience. They were conducted by Staff Biologists Donald Cox and Joan Creager.

The first minicourse was held in the urban setting of the Eastern Campus of Northern Virginia Community College. This, the largest of the minicourses, was attended by over 60 participants, mostly biology instructors from the Washington metropolitan area. The second minicourse was held at Columbia Junior College, California, a sylvan setting in the foothills of the Sierras. About 40 participants came, some

from as far south as Los Angeles and as far north as Seattle.

The last minicourse was held at Clark College in Atlanta. Most of the 30 participants came from the Atlanta University Consortium although there were a few from neighboring states. This last minicourse was more interdisciplinary than the others. While the first two included primarily biologists with a few people from chemistry or geology, the Clark minicourse was attended by people from such diverse disciplines as history, home economics, and art, along with numerous biologists.

EVALUATION AND TESTING

Panel members (address at time of appointment): Clarence H. Nelson (Chairman), Michigan State University; W. H. Bragonier, Colorado State University; Relis Brown, Florida State University; James L. Koevenig, University of Kansas; William V. Mayer, Wayne State University.

The objectives of this CUEBS' activity were in upgrading the procedures used to measure the knowledge, abilities, and skills which students attain as a consequence of their exposure to and involvement in the newer undergraduate courses. It was recognized that the development and emergence of newer course content, newer philosophies of instruction, and the use of newer techniques, media, and materials necessitated newer approaches to evaluation and testing.

The Panel on Evaluation and Testing decided that for the present one standardized placement examination would not solve the problem. Instead, a pool of test exercises might have far greater flexibility and utility. In order to make a distinctive contribution, each exercise created for this pool would have to meet certain predetermined specifications. To serve as a guide in developing a pool of test exercises that will be as nearly representative as possible of the entire spectrum of (1) content categories, (2) organizational levels, and (3) behavioral objectives, a *three-dimensional grid* was designed by this panel. The categories listed on the grid were to be regarded as tentative and subject to change if suggestions by readers and users appeared to offer improvements. The panel invited such suggestions. Each exercise created for this pool received a coding to designate its categorization on the *three-dimensional grid*. On the *X-axis* the item would be classified as to content or subject matter coverage; on the *Y-axis* as to behavioral objective embodied. Thus, for example, an item dealing with evolution at the population level, as one of a block of items devoted to analyzing the tenets of a paper on industrial melanism in moths, would be coded *X-7, Y-4, Z-4* to indicate its categorization on the three axes of the grid. If a pool of perhaps a thousand high quality test items, well distributed over the grid, could be generated, staff members from each institution might draw items from the pool, and fill in with some of their own as desired, to custom build the kind of placement examination that would best suit the local needs. Standards could be set to be in conformity with the standards generally prevailing in the local institution. Such a custom-built examination would be reasonably valid in the situation for which it was created. If staff members in several institutions where the sequencing, admission standards, and expectations from students are approximately similar wished to join forces to build one placement examination from the item pool plus some of their own item resources, the larger try-out population that would thus become available would yield more analysis data that could be used as a basis for improving the placement examination when revision was subsequently undertaken.

This project led to CUEBS Publication 20, *Testing and Evaluation in the Biological Sciences*, a collection of some 1,400 sample test items coded to the three dimensional grid to serve as models or samples measuring behavioral objectives, content of biology, and biological levels of organization. The original printing was exhausted and was reprinted by AIBS in 1969. Upon acceptance of the manuscript, the panel was dissolved and there was no further direct activity in evaluation and testing.

BIOLOGICAL FACILITIES

Panel members (address at time of appointment): C. Ritchie Bell (Chairman), University of North Carolina; J. Wendell Burger, Trinity College; L. S. McClung, Indiana University; Richard D. McKinsey, University of Virginia; Robert Leisner, AIBS; and Gerald Scherba, California State College at San Bernardino.

Planning for Biological Facilities

The panel developed and published in 1969 (CUEBS Publication 16), a series of checklists and guidelines for construction of biological facilities for education entitled *Guidelines for Planning Biological Facilities*. Demand for the packet was exceedingly high (well over two thousand on first printing) and has remained high since. Consultation, based on the guidelines, continues via the AIBS Consultants Bureau.

Upon recommendation of the panel, the CUEBS Consultants Bureau prepared a statement on consulting on biological facilities, the following portion of which is noted:

The development of new curricula in biology goes hand-in-hand with development of new facilities for implementing the courses. Questions of laboratory equipment, laboratory design, and whole building design loom large in view of the science building boom and in view of the large amounts of both public and private funds available for science buildings and equipment. Adequate planning when both programs and building techniques are in a rapid stage of flux is difficult. To aid institutions in gaining a biological perspective on their planning problems, the CUEBS Consultants Bureau offers the services of a select list of experts in such planning.

Inasmuch as the main function of the Commission is to encourage the improvement of undergraduate instruction, CUEBS cannot offer an architectural planning service. However, through its Panel on Biological Facilities, CUEBS can offer a limited amount of aid to departments renovating old facilities or building new. The Panel has prepared a "Pre-Planning Packet" consisting of: (1) guidelines on Building Planning Procedures; (2) a list of granting agencies and application procedures; (3) a list of recent buildings; (4) a specific item checklist on building facilities; (5) a bibliography of articles on science buildings and facilities; (6) an architectural terminology glossary. . . .

It is the hope of CUEBS that this program will provide any department or institution with some biological insight into their building problems at the very significant planning stages. In addition, by making available a list of highly skilled and technically competent men, CUEBS can help those architects in institutions who want help during the detailed later stages of planning and building.

Library Project, Phase I

The panel also undertook the compilation of a list of holdings in biology considered basic to a good undergraduate library. That compilation, which resulted in CUEBS Publication 22 (March 1969), *Basic Library List for the Biological Sciences*, was reached in the following way, as described in that publication:

. . . The starting point was the compilation of a list of common holdings found in the libraries of six long-established, small colleges widely recognized for the high calibre of their undergraduate instruction in biology. (The six schools were Earlham, Haverford, Oberlin, Reed, Wabash, and Wooster.) This list was limited to English language biology books published between 1945 and 1966 and included more than 10,000 volumes. "Popular books," most paperbacks, and all introductory biology textbooks were eliminated; the remaining books then were arranged into subject categories, and relevant recent books were added. The subsequent list was subjected to extensive reviews, which resulted in a number of further deletions and additions.

The present list represents the combined professional judgment of the CUEBS Executive Office professional staff, the Panel on Biological Facilities, and a special review panel from the Commission itself. Relevant portions of the list were reviewed by education committee chairmen from numerous professional societies affiliated with the American Institute of Biological Sciences; some recent titles and a number of books published before 1945, but still regarded as landmarks in biology, were added.

No library list should be used automatically and uncritically. This list has been compiled and is being issued to assist small institutions with only minimal funds available in the improvement of their library holdings. It should be stated emphatically that it does *not* represent an adequate library collection for even a small college. It represents a judgment of the very minimal holdings with which a small biology department can adequately offer a major. Continued development from this minimum should be regarded as essential. If a college had no library at all, it would be logical to recommend purchase of the entire list; but this is not the usual situation. Thus, the list should be considered in the light of existing library holdings. While the listed titles represent a professional judgment as to the few in a field that are most useful for undergraduate teaching purposes, they are not the only usable ones. If a library already has a considerable representation in a field, it should not add an additional title from this list at the expense of other more urgent needs.

Upon completion of the basic library list, the panel was discharged.

Library Project, Phase II

A complete overhaul of this booklist was represented by CUEBS Publication 32, *Guidelines and Suggested Titles for Library Holdings in Undergraduate Biology*, published in April 1971. This project, carried largely by Staff Biologist Joan Creager, developed a protocol by which this basic list can be amended through a review of the literature developing in a 2- to 3-year period. Over 300 biologists, representing a broad spectrum of colleges and specialties, evaluated books and periodicals on lists compiled from Publication 22 and from those books listed in *Choice*, *Science Books*, or the *Library of Congress Catalog* between January 1968 and March 1970. Books were evaluated as excellent, good, acceptable, or not recommended; evaluators also indicated their degree of familiarity with each book. The data obtained on the book and periodical evaluation sheets were analyzed by computer. The criteria used to determine which books to include were: at least 40% of the evaluators rated the book good or excellent; and at least 30% of the evaluators had actually used the book. On this basis, 832 of the 1,602 books evaluated were selected to appear on the list. Fifty-one additional books were added as a result of three or more independent "write-in" recommendations. The criterion used to determine which periodicals to include was that at least 40% of the evaluators rated the periodical as essential or highly desirable for upper division undergraduates. On this basis, 77 of the 97 periodicals evaluated appear in the list; in addition, 18 other periodicals were added as a result of five or more independent "write-in" recommendations. The publication was distributed widely, notably to college librarians in all institutions of higher learning in the United States and Canada.

It is anticipated that the Education Division of AIBS will, at a 2- or at most 3-year interval, update this basic list by addition and deletion.

COLLEGE INSTRUCTIONAL PERSONNEL

Panel members (address at time of appointment): Lewis E. Anderson, Duke University; Gerald A. Cole, Arizona State University; Rezneat M. Darnell, Marquette University; Richard E. Garth, Mississippi State College for Women; Artis P. Graves, Agricultural and Technical College of North Carolina; Donald G. Humphrey, Oregon State University; Willis H. Johnson, Wabash College; Robert MacVicar, Southern Illinois University; Lewis N. Pino, Oakland University; R. R.

Ronkin, University of Delaware; Martin W. Schein (first Chairman), Pennsylvania State University; Grover C. Stephens, University of California at Irvine; William K. Stephenson (second Chairman), Earlham College; Sanford S. Tepfer, University of Oregon; Charles S. Thornton, Michigan State University; Charles M. Vaughn, Miami University; Allyn J. Waterman, Williams College; Newell Younggren, University of Arizona.

The Panel first considered its role in upgrading biology instruction through summer institutes, conferences, seminar programs, fellowships, internships, and special degree programs. It increasingly recognized the need to not only consider in-service training, but pre-service training as well and therefore established subpanels to deal with each area.

The In-service Panel developed a year-long Regional Faculty Redevelopment Program. The Pre-Service Panel assembled model seminars and topics instrumental in increasing teaching effectiveness and retarding future obsolescences; a selected number of these were published in the October 1968 **CUEBS News** and several were reprinted or excerpted in Publication No. 24 (see below).

The June 1968 issue of **CUEBS News** was devoted to college instructional personnel. It includes an article, "Advanced Training—Are We on the Right Track?" based on the explorations of the Pre-service Subpanel of the Panel on College Instructional Personnel (PCIP). The In-service Subpanel of the PCIP contributed a brief description of their recommendations and two papers. "Small College Problems," by Lewis Pino, and "A Program to Strengthen Undergraduate Biological Education," by staff biologist Donald Wise, gave specific information describing the limitations on biology instruction in some small colleges and make concrete recommendations as to how the biology departments in these colleges might be able to improve their capabilities.

With the exploratory phase of their activities concluded, the Panel and its Subpanels were dissolved.

Teaching and Research

In early 1968, a letter was sent to over 100 scientists involved in teaching, research, and/or administration to stimulate the expression of their ideas concerning the relationship, if any, between research participation and good teaching. The same letter appeared as an open letter to the academic community in the April issue of **CUEBS News** (Volume IV, Number 4). The responses from over 140 biologists warranted the development of a publication similar in format to CUEBS publication No. 19, *Biology for the Non-Major*, and appeared as Publication No. 23, *Teaching and Research* in May 1969.

Pre-Service Preparation of College Biology Teachers

During 1969, a concentrated and renewed effort was made by Staff Biologist Donald Dean on the preparation of the biology teacher. The need for such an effort, long recognized by the Panel on Instructional Personnel and for which they laid groundwork, is best evidenced by a subpanel report submitted by Donald Humphrey and Donald Wise:

Of 1843 people granted Ph.D's in biological fields by 94 leading universities in the period 1963-1967:

—69% became college teachers of biology
—of these, 73% taught a beginning course.

Of these 94 universities:

—66% provided no special training to teaching assistants before they taught.
—80% offered no special course or seminar in any aspect of college teaching.

Four regional conferneces were held for representatives of those universities which supplied two-thirds of the Ph.D's., in biology. The conferences took place in Washington, D.C., September 25-26, 1969; University of Michigan, January 8-9, 1970; University of California in Berkeley, February 27-28, 1970; and New England Center, Durham, New Hampshire, May 7-8, 1970. Recommendations which were generated by those conferences appeared in CUEBS Publication 24, November 1970, *Pre-Service Preparation of College Biology Teachers*. The recommendations follow (the remaining chapters of the publication expand on these recommendations):

Recommendations to Graduate Schools

1) Give thought to the desirability of a Doctor of Arts degree or other practitioner's degree. Alternatively, consider how the needs of those who will teach in colleges and universities can be met better within the framework of the Ph.D. degree.

2) Permit truly creative investigation related to the teaching of biology to be used in appropriate cases as a dissertation.

3) Consider the suggestions presented for improving the program for teaching assistants.

4) Organize a fall conference on teaching for teaching assistants and staff. Consider an interdepartmental effort.

5) Consider developing a seminar or course on effective teaching as a companion to the teaching experience.

6) Develop with undergraduate institutions a plan for a cooperative internship.

7) Explore ways to improve the status and dignity of the teaching assistant. Explore ways to improve his sense of participation and colleagueship.

8) Examine the programs of the graduate students to see whether they provide these:

Adequate breadth of preparation for college teaching (and for research).

Research activities realistically related to the students' plans for the future so that they will not give up research as soon as the resources of the university are no longer available.

The initiation of a life-long program of professional reading and professional growth.

9) Review your program for NDEA fellows to see whether it fills the need.

10) Find ways to enlist the participation of senior members of the department in the improvement of the program for future teachers. Consider the appointment of a department coordinator of college-teacher preparation.

11) Propose to NSF or other foundations a plan for support of a person of proven creativity and ability who wants to apply his talents to developing an original contribution to the teaching of biology.

12) Include the teaching performance of faculty as one criterion for advancement.

Recommendations to Hiring Institutions

1) Appoint teaching staff for the specific qualities and preparation desired rather than the prestige of a particular degree alone. Give serious thought to what these qualities and this preparation should be, and make your wishes known to the universities.

2) Make sure that a new appointee knows exactly what is expected of him and what support he can expect. Take responsibility for giving

the new teacher a chance to get started well and to continue a program of growth throughout his career.

Funds for Undergraduate Biology Departments

As an aid to development of programs for instructional research and professional development, CUEBS recognized the need for assistance in grantsmanship. This led to Publication 29, May 1970, *Funds for Undergraduate Biology Departments and How to Find Them*, which was compiled by Staff Biologists John D. Withers and Joan G. Creager. Its aims were to attempt to anticipate questions and problems of the novice such as:

1) How to define goals and assign priorities to departmental needs, or how to get organized for proposal writing. Levels of priority to be agreed upon by the department or the institution are suggested. The department or institution is advised to develop its own ideas and prepare a preliminary statement or prospectus which will serve as a "feeler" to agencies.

2) How to negotiate with government agencies and foundations likely to support departmental needs. This section gives good hard advice to the proposal writer.

3) How to locate the right agency. Government agencies usually publish numerous brochures, describing their programs. However, few private foundations provide the same type of service; therefore it is necessary to search for these in directories or reports. The paper provides a basic library list of directories and guides to the foundations.

4) How to write the proposal. A generalized description of the format for proposals is discussed and this is supported by grantsman's checklist.

5) An annotated reference list of value to anyone who is contemplating writing a proposal.

PREPARATION OF BIOLOGY TEACHERS

Panel Members (address at the time of appointment): Benson E. Ginsburg (Chairman), University of Chicago; Charles R. Botticelli, Boston University; Alan Conger, Temple University; Aubrey Gorbman, University of Washington; J. Robert Harrison, Washington and Jefferson College; Paul Klinge, Indiana University; Ray Koppelman, University of Chicago; Addison E. Lee, University of Texas; and Edward M. Palmquist, University of Missouri.

The position paper of the Panel was published as CUEBS Publication 12 in December 1965, *Preparing the modern biology teacher: a position paper of the Panel on Preparation of Biology Teachers*. *BioScience* **15**(12): 769-772.

Biology Methods Program

An *ad hoc* Biology Methods Course Advisory Group, chaired by Addison E. Lee (University of Texas) and J. Robert Harrison (Washington and Jefferson College), recommended the development of a Biology Methods Program organized under three divisions: Philosophical elements in the preparation of biology teachers; Personal competencies and characteristics of biology teachers; and, Pedagogy for prospective biology teachers. The program was envisioned as pervading 4 years of undergraduate education, and continuing through certification and graduate study as well as the rest of the professional career. A Committee on Biology Methods was established, funded and operated jointly with Biological Sciences Curriculum Study. Committee members were (address at time of appointment): Ted F. Andrews (Chairman), Educational Research Council of Greater Cleveland; Jack L. Carter, Colorado College; Addison E. Lee, University of Texas; Alfred Novak, Stephens College; John Ransom, Kansas State Teachers College; and Alfred Sussman, University of Michigan.

The results were edited by Addison E. Lee as CUEBS Publication 25, June 1969, *Preparation of Secondary School Biology Teachers*. The chief aspect of this publication was an in-depth analysis of the biology methods program. The major components of which were identified as follows:

Philosophical Elements in the Training of Biology Teachers

A. Philosophy of the Science of Biology
   1. Develop an understanding of the aims, methods, and structure of the science of biology as inquiry. . . .
   2. Develop an understanding of the limitations of the science of biology in answering all of man's inquiries or solving all the problems of society.

B. History of the Science of Biology
   1. Develop an understanding of the history of man's attempts to understand biological phenomena through an analysis of various views of the history of the science of biology. . . .
   2. Develop an understanding of the various methods of analyzing the history of the science of biology. . . .

C. The Role of Biology, the Biologist, and the Biology Teacher in Society.
   1. Develop an awareness of the interdependence of biology and technology.
   2. Develop an awareness of the interaction of biology and society.
   3. Develop an understanding of the ethical responsibility of the biologist.
   4. Develop an understanding of the responsibilities and dangers involved when a biologist is called as an expert witness to testify before a court of law or a governmental agency.
   5. Develop an understanding of the interrelationships of biology and other disciplines. . . .

Personal Competencies and Characteristics of Biology Teachers

A. Growth as a Professional Person
   1. Develop an appreciation of the importance of participation in various professional teacher and biological organizations.
   2. Develop and strengthen self-confidence. . . .
   3. Develop an awareness of the importance of continuous self-evaluation through study of various approaches to self-evaluation.
   4. Develop an appreciation of the need for continual self-education.
   5. Develop an understanding of the responsibilities of a high school biology teacher. . . .

6. Develop an awareness of professional resources; i.e., professional societies, commission offices and publications, publishing companies, etc.

B. Administrative Relationships
   1. Develop an awareness of the proper channels of communication within school systems.
   2. Provide information on various funding programs available.
   3. Practice in determining materials, equipment and supplies needed and procedures in ordering.
   4. Develop a positive attitude toward adapting to local situations.

The Pedagogy for Prospective Biology Teachers

A. Philosophy and Rationale of Biology Programs
   1. Develop an understanding of the biology curriculum. . . .
   2. Develop an understanding of the processes involved in the selection of course content. . . .

B. Use of Instructional Media
   1. Develop an awareness of the ways in which specialized media; i.e., microscopes, models, film loops, over-head projectors, video tapes, etc., have been used and how their effectiveness has been evaluated.
   2. Provide first-hand experiences in improvising, caring for, and using the range of available instructional media.
   3. Identify sources of instructional materials. . . .

C. Classroom Techniques
   1. Develop an understanding of the learner and the learning process. . . .
   2. Develop an understanding of the various methods useful in teaching biology and how to determine when to use each. . . .

D. Knowledge of the Steps in Planning New and/or Remodeling Science Facilities
   1. Develop an understanding of basic principles underlying science facilities. . . .
   2. Develop an awareness of the desirable characteristics of secondary school biology facilities. . . .

E. Evaluation Techniques in Biology
   1. Develop an understanding of the philosophies and assumptions undergirding the practices of evaluation. . . .
   2. Develop an awareness of the various sources of evaluation materials used in teaching biology. . . .
   3. Develop an understanding of various grading systems used in teaching biology. . . .

Role-Playing Project

As a followup of Publication 25, CUEBS conducted several workshops on the use of simulated situations in science teaching for science educators and science supervisors. These workshops were conducted by David Lehman, then of the University of Texas. A manual for using simulated situations in the preparation of teachers, including a guide to conducting workshops in their use, was prepared by Dr. Lehman and published as CUEBS Publication 30, February 1971, *Role Playing and Teacher Education. A Manual for Developing Innovative Teachers.* The following excerpt indicates the intent of the publication and of the use of simulated situations:

> The *Simulated Situations* were designed for use in a typical science teaching methods course or as a part of a student teaching seminar. These situations were intended to develop the following four teaching skills:
>
> a. Guiding and evaluating students through a prestructured searching process of asking questions about a problem so that students discover certain basic scientific concepts;
>
> b. Using student questions and ideas in a discussion to trigger further questions, ideas, and answers from the students;
>
> c. Using the science teaching laboratory as a means of introducing and developing concepts through the students' own active discovery; and
>
> d. Guiding students in examining the processes by which scientific knowledge is acquired and in developing the students' own abilities to use these processes to acquire knowledge for themselves.
>
> These situations also were intended to develop three interpersonal relations skills.
>
> e. Establishing a climate of mutual respect in the science laboratory and classroom.
>
> f. Accepting and expressing appropriately their own feelings as teachers; and
>
> g. Accepting and responding adequately to the needs and feelings of individual students.

PREPROFESSIONAL TRAINING FOR THE MEDICAL SCIENCES

Panel Members (address at time of appointment); Thomas B. Roos (Chairman), Dartmouth College; Harrison M. Berry, Jr., University of Pennsylvania; Stanley N. Gershoff, Harvard University; Pauline Gratz, Columbia University; B. F. Hoerlein, Auburn University; Joseph L. Kanig, Columbia University; Robert G. Page, University of Chicago; Paul J. Sanazaro, Association of American Medical Colleges; Eugene Spaziani, University of Iowa.

The panel considered: (1) relevance of training in general biology to preparation for the medical sciences; (2) identification of second-level biology courses that might be appropriate for premedical students; and (3) relation of "liberal arts" training to the preprofessional medical student.

The Panel prepared a questionnaire designed to identify the kind of biological knowledge that the professional schools in the medical sciences expect a student to gain during undergraduate study. Some of the questions were specific, others open-ended. The questionnaire asked for 80 responses related to a *Biological Information Grid* that includes 80 areas of biological knowledge. On one leg of the grid were the following ten categories: *atoms, molecules, macromolecules, macromolecular aggregates, organelles, cells, cellular aggregate, individuals, aggregate of individuals, populations and larger associations.* On the other leg of the grid there were eight categories: *energetics, information, skills, structural diversity, development, adaptation, integration, proliferation.* Each block in the grid further identified the biological knowledge; e.g., the *cells-energetics"* block includes: *absorption, excretion, membrane transport, phagocytosis.*

The questionnaire was distributed to the deans of all medical, dental, veterinary, and public health schools in the United States and to the deans of selected, degree-

granting schools of nursing, medical technology, and pharmacy. Each dean was requested to direct copies to appropriate faculty members, including those with responsibilities for admission and for teaching in basic and clinical areas. Completed questionnaires were returned by 564 persons representing 103 different institutions (41 dental, 65 medical, 15 veterinary, 18 medical technology, 27 nursing, 45 pharmacy, and 16 other).

This survey of diverse medical science training institutions was also devised to elicit biographical information from the respondent, information on prospective curricular change within his institution, and identification of necessary background material. Results of the survey were incorporated in CUEBS Publication 27 (1969), *Biological Prerequisites for Education in the Health Sciences*. The report contained these major recommendations:

1) Recent changes in understanding of biology have already produced new approaches to biological education in high schools and colleges and are beginning to influence curricula in professional schools in the health sciences. It is therefore necessary that continuous discussion be established and maintained within institutions and between professional groups to transmit news of course changes and requirements. Several specific mechanisms are suggested, including (a) standing university committees, composed of teachers of preprofessional courses, to explore the contents and interdigitation of these courses; (b) improved catalog descriptions or supplements to catalog descriptions to provide admissions committees with more accurate and current information on the material taught in different courses and the sequence of its presentation; (c) regular symposia at meetings of societies in the health professions to inform members of these groups of new approaches both to undergraduate and professional school education; and (d) periodic reappraisal of professional school admission requirements and opportunities for advanced placement to take advantage of ongoing changes in undergraduate courses.

2) Preparation for practice in any of the health sciences must include a theoretical background in biology equivalent to that in a biology core program. It is unimportant whether this background be obtained before or after entering professional school, but recognizing the breadth of information respondents deemed necessary, preparatory education may be more efficiently gained before, rather than concurrently with, professional study. The orientation within these background areas should be toward gaining understanding rather than grades. Thus satisfactory performance in a rigorous course is preferable to superb performance in a trivial one. Special courses designed only to prepare students for professional study are inadequate.

3) Specific course requirements for preparation and admission to professional school should be kept to a minimum. This can be done by (a) keeping abreast of changes in undergraduate courses; (b) teaching all specific skills needed for practice at the professional school, rather than the preparatory level; and (c) redefining the aims of professional schools to fit the precise kinds of graduates they wish to produce. The last point requires that a student limit himself somewhat in his ultimate choice of schools, but this is done *de facto* at present; further definition of aims by each school within a profession could reduce student disillusionment and contribute to more effective education at all the various schools.

PREPROFESSIONAL TRAINING FOR THE AGRICULTURAL SCIENCES

Panel members (addresses at time of appointment): Roy A. Young (Chairman), Oregon State University; Edward G. Buss, Pennsylvania State University; Wesley P. Judkins, Virginia Polytechnic Institute; Roy M. Kottman, Ohio State University; A. L. McComb, University of Arizona; James H. Meyer, University of California at Davis; Henry S. Mosby, Virginia Polytechnic Institute; J. R. Shay, Purdue University; and R. H. Westveld, University of Missouri.

This panel was constituted to recommend in detail desirable preparation in biology for undergraduate students in agriculture, forestry, and related fields as well as to recommend related courses in physical sciences and mathematics. The panel also considered the extent to which agricultural curricula might include the same biology core program taken by other biological science majors.

The panel early recognized that it would be an Herculean task to evaluate adequately all the implications involved in the questions posed, especially when students in such divergent areas (e.g., forestry, wildlife, food science, agricultural engineering, pre-veterinary medicine) were to be considered. In an effort to obtain the broadest thinking possible, six action committees composed of scientists from universities throughout the country were created in cooperation with the Commission on Education in Agriculture and Natural Resources (CEANR). Each action committee considered one of the following areas: animal sciences, plant and soil sciences; natural resources, food sciences, bioengineering, social sciences; and each was charged with the responsibility for studying and recommending desirable preparation in the biological sciences and cognate disciplines for undergraduates majoring in the committee's area of specialization. The committees were asked to think in terms of requirements for students who will be professional scientists and agricultural production workers in the 1980's.

Summary of Action Committee Recommendations

One basic premise recurs throughout the reports: All agricultural students should take the same courses that other science students take. There should be no "special" courses in mathematics, physics, and chemistry for agricultural students.

Biological Subject Matter

Integration of the study of plants, animals, and microorganisms in an introductory sequence in biology was a strong recommendation of all committees. Opinions differed, however, on whether this sequence should begin in the freshman or sophomore year. Those who recommended delaying it until the sophomore year did so in order to allow structuring of the course at a higher level, following the study of introductory chemistry and mathematics. In this case, physics

and elements of biochemistry would be either prerequisite or corequisite.

Most committees assumed that entering students would have had BSCS biology or its equivalent in high school.

While only two committees (Social Sciences and Natural Resources) specifically suggested emphasis on economic plants and animals in the introductory sequence, several others recommended that higher organisms be used when possible in the illustration of basic biological principles.

At least two different approaches to teaching the introductory biology sequence were recommended. In one, instruction would be organized on the basis of levels of biological organization (e.g., molecular, cellular, tissue-organ, organism, population, and community) and proceed in that order. (The Plant and Soil Science Committee recommended that instruction begin and end with the organism, an entity with which the student would be more familiar.)

The second approach would be a somewhat traditional—albeit integrated—arrangement beginning with a study of matter and the least complex organisms. Instruction would then proceed to cell structure and function, growth and development, physiology, reproduction, genetics and evolution, behavior and the nervous system, taxonomy, etc., with some recognition of the features which distinguish plants from animals.

The choice of approach recommended was somewhat related to the year during which the biology sequence would be started, with the Food Science and Bioengineering Committees recommending that the "levels" approach be started in the sophomore year.

There was very little general agreement on the most appropriate theme for the introductory sequence or, indeed, whether there should be a theme. At least two committees (Social Sciences and Bioengineering) preferred an ecological theme, but several others placed more emphasis on unity in biology.

The Social Sciences Committee's recommendation limited biology instruction to a single first year course, except for farm management and agri-business majors. It recommended that ecology, behavior, and genetics be stressed in the first-year course and that more emphasis be placed at the organism, population, and community levels than at the molecular and cellular levels. This committee would use the laboratory only when it was the most efficient way of teaching concepts and principles, rather than using it simply for the teaching of techniques.

The committees recognized and generally endorsed the idea that the increasingly quantitative and analytical nature of biology should be reflected in the undergraduate courses. This appealed especially to the Bioengineering Committee. Several committees, however, cautioned against treatment of biological topics exclusively in abstract physical-chemical terms.

Mathematics

Strong support for mathematics came from all committees. It was recognized that most high schools in the future would provide pre-calculus training; thus the first required college mathematics could be a year of calculus. College students with inadequate mathematical backgrounds might be required to take pre-calculus courses without curricular credit. The increasing need for skills in statistics and data processing was recognized. Some committees recommended a second full year of mathematics, including mathematical analysis, linear algebra, and probability.

Chemistry

All committees recognized the need for organic chemistry and all except the Social Sciences Committee recommended biochemistry. In some cases, physical chemistry was recommended. Uniformly, there was dissatisfaction with the present omission or de-emphasis of the chemistry of organic compounds in most current introductory chemistry courses. The committees also stressed the need for a quantitative physical approach rather than a descriptive approach to the first-year course in chemistry.

Physics

The need for college level courses in physics was acknowledged by all but the Social Sciences Committee (which concluded that a good high school physics course was sufficient). The committees generally recommended one year of college physics. Some suggested that a course in biophysics, taught by a biologically oriented department, should be offered. The committees placed less emphasis on physics than on chemistry, but there was overlap in the recommendations for the subject-matter areas of physics and physical chemistry.

Panel Recommendations

Students in all areas of agriculture should, as a minimum, take a basic integrated general biology sequence containing concepts of organismal biology, environmental biology, and molecular-cellular biology. The treatment should be rigorous and the program should follow adequate preparation in chemistry, mathematics, and physics.

Upper division courses important to the field of emphasis (e.g., animal science, food science) should be built upon the basic biology sequence. Courses such as biochemistry, ecology, genetics, microbiology, pathology, nutrition, and physiology would be appropriate, depending upon the area of student specialization and the level of attainment sought.

Those students whose career interests are indefinite at the outset of their college career might be offered a course in applied biology to help them decide upon their goals. (Such a course might also be of interest to liberal arts students.) The course might consider such topics as an overview of the ecosystem, the relation of animals and plants to the culture of man, world food problems, etc. The course would not be prerequisite to courses in the general biology sequence.

If appropriate biology "core" curricula are developed at various institutions, all agriculture students should participate. The core should be flexible enough so that students in agricultural economics, rural sociology, or agri-business might leave it at the end of the first year with a good basic appreciа-

tion of biological principles. However, all other agriculture students should take the full core, usually two to five semesters in length, concomitant with chemistry, physics, and mathematics.

A typical curriculum in natural science for students planning careers in any area of agriculture other than agricultural economics, rural sociology, or agri-business might assume the following form:

First Year: Chemistry—General Chemistry, with emphasis on carbon compounds. Mathematics — Introductory calculus, linear algebra (See courses 1 and 3, CUPM report).[1] Physics — General Physics.

Second Year: Biology[2]—Organismal biology,[a] environmental biology,[b] and cellular-molecular biology.[c] Chemistry—Organic chemistry plus physical chemistry or biochemistry. Mathematics—Probability (See course 2p, CUPM report).[3] Physics—As required by field of emphasis.

Third Year: Biology—Selected courses in areas basic to field of interest (e.g., biochemistry, ecology, genetics, microbiology, nutrition, pathology, physiology).

Fourth Year: Biology—Specialized biology, systems biology, and population biology.

The above recommendations are based upon the following premises:

A) The undergraduate curriculum should allow for emphasis in three major areas: (1) graduate study, which embodies strong requirements in the basic sciences; (2) work of a technological nature, which may require some graduate work to increase the depth of knowledge; (3) work in the "management" areas, which may require a fifth year of study.

B) At the advanced levels, the undergraduate curriculum should allow for differences in depth and emphasis. The food sciences, for example, may need concentrated work in molecular and cellular biology; natural resources may need additional emphasis upon population and community biology; etc.

C) The undergraduate curriculum should offer flexibility to students. Many students change their majors prior to graduation. Concentration on basic science and mathematics courses during the initial years will enable students to shift career objectives without serious loss of time.

[1] **A General Curriculum in Mathematics for Colleges, 1965.** Committee on the Undergraduate Program in Mathematics (CUPM), P. O. Box 1024, Berkeley, California 94701, p. 76.

[2] Following are examples of topics that would be included in such courses. No sequential order is implied by order of listing.

[a] Structural and functional organization of higher plants and animals; physiology, growth and differentiation, morphology, organization of higher organisms; contemporary topics such as biological clocks, photoinduction of flowering, neural secretions, behavior, and self-recognition mechanics.

[b] Concepts of the ecosystem, including energy exchange, productivity, physical limiting factors (light, temperature, water, and radiation) and biological limiting factors; structure and dynamics of populations and communities; fresh water, marine and terrestrial habitats; ecology and human welfare, including agriculture, natural resources, and public health.

[c] The chemical and physical properties of cells, enzymes, and chemical reactions, cellular differentiation, stimuli and response characteristics, sexual and asexual reproduction, and mutations in genetic apparatus and DNA.

[3] A General Curriculum in Mathematics for Colleges, 1965. Ibid.

INTERDISCIPLINARY COOPERATION

Panel Members (address at time of appointment): Aubrey W. Naylor (Chairman), Duke University; Charles C. Bowen, Iowa State University; A. Gib DeBusk, Florida State University; David M. Gates, Missouri Botanical Gardens; J. W. Hasting, University of Illinois; Henry Koffler, Purdue University; Fred Snell, State University of New York at Buffalo.

Chemistry Interface

The panel initiated, in cooperation with the Advisory Committee on College Chemistry (AC_3), publication of a series of monographs concerned with the biology-chemistry interface. From 12 to 15 paperbacks, about 150 pages long, were envisioned to cover topics such as: Catalysis; Chemical Evolution; Electron Transfer Phenomenon; Geometry of Molecules; Interaction of Radiation and Matter; Information Storage and Retrieval in Molecular Systems; Macromolecules; Organic Reaction Mechanism; Surfaces, Films, and Membranes. The editorial board consisted of: Charles C. Price, Editor (University of Pennsylvania); L. Carroll King (Northwestern University); Leonard K. Nash (Harvard University); Robert H. Burnis (University of Wisconsin); and Aubrey W. Naylor (Duke University). Five years later, in 1970, the first two volumes in the suggested series appeared. They were *Light and Living Matter, Volume 1: The Physical Part* by Roderick Clayton, and *Introduction to Organic Reaction Mechanisms* by Otto Benfey. Both volumes were published by McGraw-Hill Book Company, New York.

Mathematics Interface

In cooperation with the Committee on the Undergraduate Program in Mathematics the panel produced a booklet of biological-mathematical problems, identifying those areas of mathematics most suitable for biologists, and to integrate mathematical concepts into biological instruction so as to enhance the simultaneous development of biological and mathematical sophistication. This project was conducted by: Robert M. Thrall (University of Michigan); H. Robert Van der Vaart (North Carolina State University); Henry Koffler (Purdue University), and Fred M. Snell (State University of New York at Buffalo).

General

The panel was discharged upon completion of these two projects. Subsequently, in the spring of 1968, CUEBS

convened an *ad hoc* committee whose charge was to develop approaches to subject matter which might yield a fresh understanding of interface relationships and lead to a meaningful integration of biology and other disciplines. Committee members were Garrett J. Hardin, University of California, Santa Barbara; John R. Platt, University of Michigan; and Arnold T. Towe, University of Washington School of Medicine. CUEBS Director Martin W. Schein worked with this committee.

One approach developed by the committee was described as project-oriented. It involved studying a cluster of things because they are relevant to one another at a particular time. One member of the committee was to prepare a model of such materials directed toward the social sciences; another was to construct a model in the physical sciences. Materials on other topics might then be patterned after these models.

A second approach suggested the idea of organizing individual courses—and eventually, perhaps entire curricula—from the perspective of systems analysis. A small working conference, following collection of sample models, was proposed as a means of considering this approach.

No products issued from this committee.

Physics, Agriculture, and Natural Resources

In November 1968, CUEBS cosponsored with the Commission on Education in Agriculture and National Resources (CEANAR) and the Commission on College Physics (CCP) a "Working Conference on Source Material in Physics-Biology-Agriculture and Natural Resources." The rationale for this conference, attended by 15 persons representing these areas, recognized that: "1. existing physics courses do not serve ideally the needs of majors in biology, agriculture and the natural resources; 2. it is not practicable or desirable to have a separate elementary physics course for every group of students with distinguishable career goals; 3. a solution which appears hopeful is to create new materials in modules. . . ." The conference developed details of modular format and recommended the following topics in order of importance: radiation and optics; electricity and magnetism; molecular physics and fluid dynamics; mechanics and sound. A protocol for development, testing, and publication was developed but further effort was precluded by the fiscal cutback each of the Commissions experienced in 1968-69 and by the impending operational phase-out of the Commissions.

The Environmental Education Movement

This problem-focused, interdisciplinary education movement was initiated after the interdisciplinary panel had completed its work. Two major products developed from staff efforts. First, there was a special issue of **CUEBS News** in March 1970 to coincide with April 20—E Day. This issue of the **News**, whose original printing of 20,000 copies was replenished by an additional 20,000 copies, explored making the problems of achievement and maintenance of environmental quality academic problems by examining the "state of the art" in campus organizations; scientist-citizen coalitions; symposia, seminars, and short courses; new courses; institutes and centers; colleges and schools.

This was followed in 1972 with CUEBS Publication 35, April 1972, *Environmental Education: Academia's Response*, the result of a joint project with The Conservation Foundation through its Education Director, James Aldrich, and CUEBS Director, Edward Kormondy. Statements were collected from the following 15 institutions whose programs highlighted the range of issues that characterize different institutional responses to interdisciplinary environmental studies: College of the Atlantic, Dartmouth College, Evergreen State College, Hampshire College, Huxley College (Western Washington State College), Indiana University, Pennsylvania State University, Prescott College, State University of New York at Buffalo, University of British Columbia, University of California at Santa Cruz, University of Michigan, University of Wisconsin at Green Bay, University of Wisconsin at Madison, and Williams College. Statements were addressed to original goals and their subsequent modification, relation to other university/college activities, significance of institutional governance issues, particular problems, and future priorities.

CONFERENCES

In addition to conferences conducted by the various panels and larger program activities, and a number of intercommission conferences, several specific kinds of conferences were conducted by the Commission.

Conferences on Undergraduate Curriculum for Biology Majors

Three conferences bearing this theme were held in St. Louis in May 1964, May 1965, and September 1967. Each was attended by some 50 college and university biologists, and with few exceptions, the same participants (or their alternates) attended subsequent conferences to maximize followup on interim developments.

At the first conference it was generally acknowledged that the then typical introductory course needed to be expanded to constitute a sequence of courses or "core programs," most or all of which would be taken by all future biologists of whatever intended area of biological specialization.

The second conference focused on the practical and strategic aspects of curricular reform and was summarized by the conference Chairman, Thomas Hall, in an article entitled, "How to Move a Cemetery" (**CUEBS News**, February 1966). Excerpts from that summary follow:

Are teaching-loads a barrier to reform? In the sorts of institutions represented at the conference—large and complex universities, private universities, liberal arts colleges, teacher training institutions—heavy

teaching loads are a serious problem. Significant curricular improvements require both *summer salaries* and reduced *academic year loads* for teachers who have legitimate interests in curricular innovation. Federal agency financing only partly solves this problem. Furthermore, it seems clear that, quite aside from the *ad hoc* cost of innovation, keeping abreast of the "new biology" is increasingly demanding of professional time just because of its highly technical content and its rapid rate of growth. Too heavy a teaching load virtually guarantees *the twin vices of professional stagnation and curricular anachronism.*

How much of an obstacle are physical limitations? Space and equipment were unanimously recognized as factors limiting curricular progress. If the core-concept spreads rapidly beyond the institutions in which it has already been initiated, new teaching installations (especially teaching laboratories and equipment) will be needed to permit undergraduates, including freshmen and sophomores, to do more work than they are now doing in cytology, physiology, microbiology, genetics, and even elementary biochemistry (which is increasingly represented in progressively constituted laboratory exercises and textbooks). The demand for such new physical facilities may rapidly outstrip the availability of support.

Do student inabilities and lack of preparation inhibit reform? This is an old problem with a new acuteness. It is increasingly impossible to talk about living systems without the use of chemical concepts, including ones of considerable sophistication. If we could count on having all or most of our incoming students well trained in chemistry in high school —say with a good twelfth-grade course of the type recommended in the high school curriculum studies—the problem would be less severe. What we can assume, in fact, from this direction, differs in different sorts of colleges. It is probably already true that in hard-to-enter private colleges, most entering students have studied some chemistry in high school. In any case, earlier studies conducted by CUEBS suggest that in strong institutions, introductory core biology tends to become a *sophomore course, with freshman chemistry as a prerequisite and organic chemistry taken concurrently.*

To what extent are local administrative attitudes and procedures an impedance to curricular revision? The administrators came off, in general, rather well in this part of the discussion at St. Louis. (Administrative interest in curricular improvement was reported to be greater in some institutions than that of the teaching staff.) It was felt, however, that administrators do not always realize the immense cost—in time, energy, and money—that significant innovation implies.

To what extent does local faculty inertia (or even incompetence where it exists) impede curricular progress? In answer to this delicate question it was admitted that inertia and incompetence are widespread and that they manifest themselves in quite different ways in different situations. Each local situation thus requires a partly individualized solution. Two things, in general, seem needed: better opportunities for the continuing scientific education of college teachers, including programs now barely exploited; and, above all, the encouragement within every institution of an open spirit toward experimentation and revision by those with talent to undertake it. How to convert these from pious exhortations into practical action programs is a question urgently in need of creative attention.

How clear a concurrence is there concerning the meaning and content of the core? This question elicited the appeal by many conference participants that CUEBS do something to clarify the core idea. It is generally enough recognized that the indispensible central core of biological knowledge has grown by leaps and bounds. In effect, this implies *the expansion of the present single introductory biology course into a sequence of such courses.* Such a sequence is *the* core. However, there is far from any agreement on what the core should encompass. Ultimately, this is a question which most enlightened groups, e.g., the members of a department cooperating in curricular revision, will wish to decide for themselves.

The third conference was summarized in an article entitled, "The Everchanging Curriculum" in the February 1969 issue of **CUEBS News.**

Conference on Education in Biology

To discuss contributions of the professional (discipline-oriented) biological societies to the improvement of biological education, two conferences were held, one in December 1965 and the second in November 1967. The recommendations generated during the first conference, which was attended by 50 representatives of the professional societies, were as follows:

1) Societies should recognize their responsibilities to education in their discipline areas, often transcending the needs of their immediate members. A standing committee on education is a step in this direction.

2) Societies should take advantage of existing opportunities in education, and play an active role in creating and staffing summer institutes and conferences, as well as shorter programs in connection with annual and regional meetings.

3) It is a legitimate function of discipline-oriented societies to review textbooks, especially on elementary and secondary levels, and to adapt research material for classroom exercises.

4) Some societies should consider broadening the base of their membership in order to include many teachers of biology who could benefit from association with professional biologists, but presently may not qualify for membership.

5) Societies might emphasize in their publications and meetings the importance of excellence in teaching as well as excellence in research. To this end space might be provided in their publications for articles relating to the teaching of biology. Outstanding teaching awards might be given.

6) The prestige of societies might be used to influence administrators to allow adequate financial support for attendance at meetings, and for the provision of adequate service personnel to take over many routine chores in college teaching.

7) Societies must consider the problems associated with broadening the basis of Ph.D. training to include preparation for college teaching.

8) The groups also recommended continued liaison among the education committees of the societies, through conferences such as this or through other means.

A third and fourth conference were conducted subsequently by the AIBS under a special grant from the National Science Foundation.

Conference on Administration of Biology in Large and Complex Universities

A planning meeting on the Administration of Biology in Large and Complex University (BIOLU) was held July 17-18, 1967, in San José, California. The meeting involved a small number of administrators and scientists who were seeking the best way to favorably affect the administration of biology in this particular type of institution.

The group determined that future action should be designed with these purposes in mind: (1) to convene administrators and scientists for the purpose of analyzing the impact of the changing curriculum on the administrative structures which guide biology in large and complex universities; (2) to provide information about problems and solutions which

have arisen in new and innovated approaches to administration in the biological sciences; and (3) to recommend administrative patterns which will improve the operational setting in which biological education and research occur.

After his tenure as Associate Director, David G. Barry, then of San José State College, worked with the Executive Office on a project on the administrative structure of biology in large universities. He submitted a report to CUEBS outlining two separate plans, referred to as Programs I and II.

Program I would be an attempt to describe the theoretically ideal model (or models) for the administrative structure of biology in large and complex universities. This would be accomplished by asking a selected number of individuals to develop essays outlining their concepts of the ideal administrative structure in biology in Utopia University .

The essays would be edited to produce a significant CUEBS publication. The editing would include an appropriate summary whose main purpose would be to collect the common threads from the individual models. Whether this would produce a single "master model" is not determinable in advance; it probably would not, and it may not even be desirable that it should.

The second Program would deal with the "real world." The project would include preparation of a number of case studies on biological organization at specific institutions.

The two phases of the study—the ideal and the real—would then be considered in a conference or a series of conferences on the administration of biology.

This project died aborning, but fortunately the administration in 10 major universities was discussed by Aubrey Gorbman, University of Washington, in the January 1969 issue of *BioScience*. CUEBS reprinted this article and gave it wide circulation.

State and Regional Conferences

Early on, the Commission sponsored four regional conferences to engage biologists in meaningful dialogue about CUEBS' activities and their own practices and innovations. These regional conferences were as follows: Western Regional Conference (Boulder, Colorado), August 22-23, 1964; Midwestern Regional Conference (Lawrence, Kansas), October 9-10, 1964; Northeastern Regional Conference (New York City), November 6-7, 1964; Southeastern Regional Conference (Charlottesville, Virginia), April 15-17, 1965.

Subsequently, a number of state and regional conferences on undergraduate education in biology were held. Local sponsoring groups carried the initiative for the programs and arrangements and provided the continuity that extended the work into the future.

A composite list of objectives from the many conferences included the following goals: (1) to bring biologists together for face-to-face discussions; (2) to open new avenues of articulation between the various colleges (especially between two- and four-year campuses); (3) to permit opportunities for in-depth discussions of educational or teaching innovations which have been tried on local campuses (e.g., audio-tutorial programs and team teaching); (5) to acquaint regional biologists with trends and changes in curriculum programs developing on the national scene; (6) to establish organizations and action groups for continuation of discussions and planning on common regional problems; and (7) to generate professional understanding and involvement in processes of accrediting, evaluations, etc., at state and regional levels.

Many of these objectives match those of several national organizations (i.e., the state academies of science, the American Institute of Biological Sciences, the National Association of Biology Teachers, The American Association for the Advancement of Science, etc.). These organizations have great potential strength and influence professional trends at the national level. It is often desirable, however, to deal with issues at state or regional levels, and to involve working biologists directly in action programs. Travel costs, space requirements, and size alone limit what can be accomplished in large national conferences.

State academies of science, of course, are organized on a state and regional basis. However, state academies are generally concerned with the broad spectrum of sciences. A program concerned with in-depth discussions of biological curriculum problems does not fit easily into the format of a typical academy meeting.

At each of the state or regional conferences held, CUEBS supplied from one to three persons as representatives. In some conferences, these people served as feature speakers; in others they served as resource persons or observers with general responsibilities. In many of these conferences, CUEBS' cooperation began with the initial planning stages; in others, CUEBS' participation was limited to the final program. In all cases, however, the responsibility for the programs, planning, financing, etc., of the conferences rested with the local groups.

Of greater significance is the fact that several of these gatherings resulted in rather loose-knit but permanent associations which aim to keep the CUEBS' "spirit" alive through annual meetings. Maryland, metropolitan New York, Missouri, Oklahoma, South Carolina, Virginia, and Washington are among those which have or are establishing continuing organizations. Several of these are now completely self-supporting through modest dues.

Of far greater antiquity than even CUEBS is the Ohio Collge Biology Teachers Conference which was organized in 1956 and is still going strong. Also, the Association of Midwest College Biology Teachers operates on a much wider geographical basis than any of the aforementioned groups. All these groups, and those which hopefully will yet be formed, are a vitally needed component of improving undergraduate education.

The 99 state and regional conferences in which CUEBS participated were the following:

1966: February 5—Oregon Biology Conference, State Department of Education, Salem, Oregon; April 1-2—Georgia Biology Curriculum Conference, University of Georgia, Athens, Georgia; September 30-October 1—Midwest Conference on Articulation in the Sciences, Hotel Kirkwood, Des Moines, Iowa; October 14-15—Colorado-Wyoming Conference on

Undergraduate Education in Biology, Colorado State University, Fort Collins, Colorado; November 11-12—Conference on College Biology, University of Puerto Rico, Rio Piedras, Puerto Rico; November 12—Ohio College Biology Teachers Conference, College of Mount St. Joseph on the Ohio, Mount St. Joseph, Ohio; December 2-3—Conference on the Undergraduate Biology Curriculum in Kansas, University of Kansas, Lawrence, Kansas.

1967: February 10-11—Conference on Undergraduate Education in Biology, Arizona State University, Tempe, Arizona; March 31-April 1—Mid-Hudson, Berkshire, Connecticut Valley Regional Conference, Dutchess Community College, Poughkeepsie, New York; April 7-8—Conference on Undergraduate Education in Biology, Indiana University Medical Center, Indianapolis, Indiana; April 21-22—Washington State Biology Conference, Stekekin Lodge, Lake Chelan, Washington; April 29—Bioinstructional Improvement Organization of Twin City Area, Hamline University, Saint Paul, Minnesota; May 5-6—Biology in the California Public Colleges, San José State College, San José, California; May 5-6—Michigan Conference on Undergraduate Biology, Western Michigan University, Kalamazoo, Michigan; May 12-13—Northern Plains Conference on Undergraduate Biology, University of South Dakota, Vermillion, South Dakota; May 12-13—Virginia Conference on Education in Biology, Virginia Polytechnic Institute, Blacksburg, Virginia; May 26-27—Hawaii Biology Conference, University of Hawaii, Honolulu, Hawaii; June 2-3—The Conference on the Undergraduate Biology Curriculum, Paterson State College, Wayne, New Jersey; September 30—Wisconsin Conference on Biological Education, Wisconsin State University, Oshkosh, Wisconsin; October 6-7—West Texas Region on Undergraduate Biology, Howard County Junior College, Big Springs, Texas; October 13-14—Alabama Biology Conference, Birmingham-Southern College, Birmingham, Alabama; October 13-14—Louisiana Conference on Undergraduate Biology, Louisiana State University, Baton Rouge, Louisiana; October 14—Arizona Biology Conference, Mesa Community College, Mesa, Arizona; October 19—Southeast Texas Conference on Undergraduate Education in Biological Sciences, University of Houston, Houston, Texas; October 20-21—Massachusetts Biology Conference; October 27-30—Tennessee Conference on Undergraduate Biology; November 3-4—West Virginia State Conference, Mt. Chateau State Park, West Virginia; November 17-18—North Texas State University, Denton, Texas; November 17-18—Baylor University, Waco, Texas; December 2—East Texas State University, Commerce, Texas; December 1-2—Arkansas Biology Curriculum Development Conference, The Arkansas State Teachers College, Conway, Arkansas.

1968: February 16-17—University of Colorado, Boulder, Colorado; February 16-17—Abraham Baldwin Agricultural College, Tifton, Georgia; March 1-2—Samford University, Birmingham, Alabama; March 1-2—Texas A&I University, Kingsville, Texas; March 15-16—Rider College, Trenton, New Jersey; March 22-23—Vassar College, Poughkeepsie, New York; March 22-23—Bucknell University, Lewisburg, Pennsylvania; March 29-30—Hofstra University, Hempstead, New York; April 5-6—Oklahoma State University, Stillwater, Oklahoma; April 5-6—Virginia Polytechnic Institute, Blacksburg, Virginia; April 18-19—Sam Houston State College, Huntsville, Texas; April 20—Phoenix College, Phoenix, Arizona; April 26-27—San José State College, San José, California; April 26-27; Ricks College, Rexville, Idaho; April 26-27—State University College, Brockport, New York; May 17-18—Southern Illinois University, Carbondale, Illinois; October 4-5—Hardin-Simmons University, Abilene, Texas; October 11-12—Tennessee Technological University, Nashville, Tennessee; October 18-19—Stanislaus State College, Turlock, California; October 18-19—Hartwick College, Oneonta, New York; October 24-25—Dominican College, Houston, Texas; October 25-26—Texas A&M University, College Station, Texas; October 25-26—University of Redlands, Redlands, California; November 8-9—State College at Bridgewater, Bridgewater, Massachusetts; November 15-16—Temple Junior College, Temple, Texas; November 15-16—Northern Illinois University, De Kalb, Illinois; November 16—Central State University, Wilberforce, Ohio; November 22-23—Hendrix College, Conway, Arkansas.

1969: February 14-15—Western Michigan University, Kalamazoo, Michigan; March 6-7—Bloomsburg State College, Bloomsburg, Pennsylvania; March 6-7—Laredo Junior College, Laredo, Texas; March 7-8—Louisiana State University, Baton Rouge, Louisiana; March 14-15—Rio Hondo Junior College, Whittier, California; March 28-29—Colorado State College, Greeley, Colorado; March 28-29—College of William and Mary, Williamsburg, Virginia; April 18-19—C. W. Post Campus of Long Island University, Brookville, New York; April 25—Tarrant Junior College, Ft. Worth, Texas; May 16-17—New Mexico Highlands University, Las Vegas, New Mexico; September 26—Maryland College Biology Teachers Conference, Emmitsburg, Maryland; October 3-4—Missouri Conference on College Biology, Warrensburg, Missouri; October 10—Western North Carolina Conference on College Biology, Montreat, North Carolina; October 17-18—East North Carolina Conference, Greenville, North Carolina; October 31-November 1—West Texas and Eastern New Mexico Regional Conference, Texas Tech University, Lubbock, Texas; November 6—North Carolina State College at Raleigh; November 8—Ohio College Biology Teachers Conference of Wooster, Wooster, Ohio; November 14-15—South Carolina State Conference at Clemson; November 14—Central Texas Work Conference on Undergraduate Biology, Navarro Junior College, Corsicana, Texas; November 14—Arkansas Biology Curriculum Conference, Arkadelphia, Arkansas; November 20-21—Kentucky State Conference, Centre College, Danville, Kentucky; November 21-22—3rd Annual Massachusetts Biology Conference, Southeastern Massachusetts University, North Dartmouth, Massachusetts.

1970: February 6—North Central Texas Work Conference on Undergraduate Education in the Biological Sciences; March 6-7—Louisiana State Conference on Education in the Biological Sciences, Southern University, Baton Rouge, Louisiana; April 17-18—4th Virginia Conference on Education in Biology,

Randolph-Macon Woman's College, Lynchburg, Virginia; May 1-2—Millersville State College, Millersville, Pennsylvania; September 25-26—Maryland College Biology Teachers Conference, Charles County Community College, La Plata, Maryland; October 8-9—East Texas Interregional Curriculum Conference, Sam Houston State University, Huntsville, Texas; October 9-10—Northwest Regional Conference on Biological Education, Reed College, Portland, Oregon; October 17—South Carolina Articulation Conference, The University of South Carolina, Columbia, South Carolina; October 30-31—4th Annual Arkansas Biological Curriculum Development Conference, University of Arkansas, Fayetteville, Arkansas; October 30-31—Missouri Conference on Biology, Lincoln University, Jefferson City, Missouri; November 13-14—West Texas and Eastern New Mexico 1970 Regional Conference, West Texas State University, Canyon, Texas; November 13-14—Ohio College Biology Teachers Conference, Kenyon College, Gambier, Ohio.

1971: February 19—North Texas Regional Conference, El Centro College, Dallas, Texas; March 5—Louisiana Conference on Education, Nicholls State University, Thibodeaux, Louisiana; April 2-3; Virginia Conference on Education in Biology, Virginia Western Community College, Roanoke, Virginia; April 2-3—Mid-South Regional Conference on Undergraduate Biological Education, Memphis State University, Memphis, Tennessee; April 16-17—Kentucky Conference on the Life Sciences, Berea College, Berea, Kentucky; April 23-24—Science Division, Alabama Association of Junior Colleges, Alexander City State Junior College, Alexander City, Alabama.

THE CONSULTANT BUREAU

The CUEBS Consultant Bureau was established in 1964 as one of the first formal activities of the Commission. It was designed to assist colleges and universities in securing the services of colleagues who could act as consultants on various aspects of undergraduate biological education. The Bureau enabled an institution to call upon an outsider for analysis and advice on course and curriculum improvement, staff needs, new instructional materials, laboratory facilities and equipment, and review of library resources. Consultants were also available under a second program (the CUEBS Facilities Consultant Service—see under Facilities) for institutions planning to construct new buildings. Consultants with appropriate experience could also be called upon to discuss administrative needs and problems.

Institutions which used the CUEBS Consultant Bureau were generally quite enthusiastic about its value. Possibly because he is not a part of the academic structure of the college or university being evaluated, a consultant may be better able to evaluate this structure than someone more closely involved. Merely because the consultant is a person from outside of the college or university seeking his services does not, of course, ensure that the opinions he expresses are entirely objective in nature. Like all humans, consultants have their own preferences and prejudices; no two persons visiting the same campus are likely to derive precisely the same set of opinions and recommendations. Thus every consultant accepted personal responsibility for any views and recommendations expressed during his visit or in his written report. The role of CUEBS in the Consultant Bureau program was merely one of providing contact between the institution seeking a consultant's services and one or more biologists who were willing to serve as consultants. To aid him during his visit, CUEBS made available to the consultant all of the information at the Commission's disposal concerning curricular trends across the country, and importantly, developed a detailed Institutional Information Form which was completed by the host institution before the consultation took place.

Consultants were reimbursed by CUEBS or by the applicant institution for travel expenses not to exceed air coach service costs. A fee of $75 per day was paid (again, by CUEBS or by the applicant institution) for a maximum of 2 days spent on the campus and for not more than 2 additional days for the development of the final report. The final report was confidential, copies going to the institution and to the Consultant Bureau files.

Consultants were appointed for a 3-year term and were selected from nominees submitted by other consultants, CUEBS staff, and Commissioners. To economize, regionalization of consultants was achieved.

In 1968, after some 100 consultant visits, the operation of the Consultants Bureau was assumed by the Education Division of AIBS under a new grant from the National Science Foundation.

PUBLICATIONS

CUEBS News was initiated in February 1965, was published bi-monthly, and terminated in January 1972. The second issue of the **News** was mailed to some 5,000 persons, and the last several volumes to over 18,000. The earlier issues dealt largely with reports of Commission activities and consisted of material developed largely by the staff and/or Commissioners. The latter issues continued to carry articles and reports of Commission and staff activity, essays by the staff and, significantly, articles contributed by college biologists across the country.

Foreseeing the termination of Commission activity and of the **News**, CUEBS convened a Conference on the Publication of Biological Education Materials on May 1, 1970. Participants included representatives of: *The American Biology Teacher*, *Bios*, *BioScience*, *Journal of Research in Science Teaching*, *Journal of Biological Education*, and *The Science Teacher*. Deliberation on various alternatives, and particularly in the light of then current journal economics, indicated the wisdom of seeking outlet in existing journals, especially *BioScience* and *The American Biology Teacher* in

lieu of initiating a new journal. The happy outcome was the initiation in fall 1972 of the AIBS *Education Division News* which gave promise of continuing and expanding the function of **CUEBS News.**

CUEBS Publication Series

A total of 35 numbered publications and two working papers constituted the published legacy of CUEBS' activity. Most of these represented "position papers" in documented form; several constituted reports of various major conferences. In addition, CUEBS purchased and distributed reprints of pertinent articles by staff and/or Commissioners which complemented and/or supplemented Commission efforts.

Demand for publications varied, as might be expected. As a measure of demand, and in response to specific inquiry by the Commission, during the period of August-October, 1970, 1,900 individual publication requests were processed and involved 3,300 copies of numbered publications, 300 copies of reprints, and 400 copies of working papers. During the last 3 years of activity, new publications were printed in amounts of 20,000-25,000 copies and several were reprinted as supplies became exhausted. In the list of publications which follows, those indicated by an asterisk are still available through the Education Division of the AIBS.

1. New directions in biology teaching. Thomas S. Hall. April 1964.
2. Report on the activities of the Commission on Undergraduate Education in the Biological Sciences. July 1964.
3. Core studies for undergraduate majors: a report on the CUEBS Berkeley and St. Louis Conferences. August 1964.
4. Some information about CUEBS. 1964.
5. Undergraduate origins of nonservice fellows in the biological sciences. 1964.
6. Report of the Western Regional Conference on Courses and Curricula in the Biological Sciences. 1965.
7. The Consultant Bureau (Revised 1967).*
8. Report of the Midwestern Regional Conference on Courses and Curricula in the Biological Sciences. 1965.
9. Report of the Northeastern Regional Conference on Courses and Curricula in the Biological Sciences. 1965.
10. Report of the Southeastern Regional Conference on Courses and Curricula in the Biological Sciences. 1965.
11. Report of the Conference on the Training of Biology Teachers. 1965.
12. Preparing the modern biology teacher: A position paper of the Panel on Preparation of Biology Teachers. December 1965.
13. CUEBS and the preparation of biology teachers. August 1965.
14. Report of the Panel on Instructional Materials and Methods. October 1966.
15. Biology in a liberal education. Report on the Stanford Colloquium. February 1967.
16. Guidelines for planning biological facilities. August 1966.
17. Report of the Panel on Preprofessional Training for the Agricultural Sciences. April 1967.
18. Content of the core curricula in biology. Report of the Panel on Undergraduate Major Curricula. June 1967.
19. Biology for the non-major. October 1967.
20. Testing and evaluation in the biological sciences. November 1967.*
21. Reports of the Action Committees of the Panel on Preprofessional Training for the Agricultural Sciences. 1967.
22. Basic library list for the biological sciences. March 1969.
23. Teaching and research. May 1969.*
24. Preservice preparation of college biology teachers: a search for a better way. November 1970.*
25. The pre-service preparation of secondary school biology teachers. June 1969.*
26. Biology in the two-year college. April 1969.*
27. Biological prerequisites for education in the health sciences. June 1969.
28. Investigative laboratory programs in biology. December 1969.
29. Funds for undergraduate biology departments . . . and how to find them. May 1970.*
30. Role playing and teacher education. March 1971.*
31. The use of modules in college biology teaching. April 1971.*
32. Guidelines and suggested titles for library holdings in undergraduate biology. June 1971.*
33. The laboratory: a place to investigate. April 1972.*
34. The context of biological education: the case for change. September 1972.*
35. Environmental education: Academia's response. April 1972.*

CUEBS Working Papers

1. A symposium on investigative laboratory programs in biology. 1968.*
2. A working conference on source material in physics-biology-agriculture and natural resources. 1970.*

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